WAR DEPARTMENT TECHNICAL MANUAL

TM 9-1825B

ORDNANCE MAINTENANCE

ELECTRICAL EQUIPMENT (AUTO-LITE)

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TM 9-1825B, Ordnance Maintenance: Electrical Equipment (Auto-Lite) is published for the information and guidance of all concerned.

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(For explanation of symbols, see FM 21-6)

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CHAPTER 1

INTRODUCTION

Paragraph

1. SCOPE.

a. This manual is published for the information and guidance of ordnance maintenance personnel. It contains illustrations, descriptions, and detailed instructions for maintenance, inspection, disassembly, repair and assembly of the following items manufactured by the Electric Auto-Lite Company for use in ordnance vehicles.

(1) GENERATORS.

Group 1	Group 2		Group 3	Group 4
GAS 4151	GDM 4803	GEG 5004A	GBG 4601	GFR 4801
GAS 4166	GDM 5001	GEH 4806	GBG 4612	GFR 4801A
GAS 4172	GDZ 4801	GEH 5002	GDJ 4802A	GFR 4801B
GDE 4107	GDZ 4801B	GEW 4802	GDJ 4804	GFR 4802
GDE 4108	GDZ 4801C	GEW 4803	GDJ 4804A	GFR 4802A
	GDZ 4801D	GEW 4803A	GDJ 4804B	GFR 4802B
	GEA 4802A	GEW 4804	GDJ 4804C	GFR 4803
	GEB 4810	GEW 4805	GDJ 4808	GFR 4803A
	GEG 5001A	GEW 4806	GDJ 4808A	GFR 4803B
	GEG 5002	GEW 4806A	GDJ 4809A	GFR 4804A
	GEG 5002A	GEW 4806B	GDJ 4809B	GFR 4804B
	GEG 5002B	GEW 4806C	GDJ 4812A	GFR 4804C
	GEG 5002C	GFK 4801	GDJ 4819A	
	GEG 5002D	GFM 4801	GDJ 4820A	
	GEG 5002E	GFM 4801A	GFZ 4801A	
	GEG 5002F	GGA 4801A	GFZ 4801B	

(2) REGULATORS.

Group 1	Group 2	Group 3	Group 4	
CB 4014	TC 4328A	VRP 4001A	VAC 4001A	VRH 4101C
		VRP 4002C	VAD 4103A	VRH 4102A
		VRP 4004G	VAD 4105A	VRH 4104A-1
		VRP 4006E	VAD 4106A	VRH 4104B-1
		VRS 4004B	VAD 4106B	VRH 4104C-1
		VRX 4001A	VAL 4101A	VRH 4105A
			VAM 4101A	VRH 4106A
			VRA 4102A	VRY 4201A
			VRA 4105A	VRY 4201B
			VRG 4102B	VRY 4203A
			VRG 4103C	VRY 4203B

INTRODUCTION

(3) DISTRIBUTORS.

Group 1			Group 2	Group 3
IGC 4054D	IGC 4707	IGS 4111-1	IAC 4001	IGW 4049
IGC 4281	IGC 4707-1	IGS 4112	IAC 4002	IGW 4053
IGC 4286	IGC 4708	IGS 4112-1	IAC 4002A	IGW 4147
IGC 4701	IGC 4709A	IGS 4114	IAC 4003	IGW 4154
IGC 4701-1	IGC 4710	IGS 4114-1		IGW 4156A
IGC 4701-2	IGC 4710-2	IGS 4202A		IGW 4165A
IGC 4702A	IGC 4716	IGS 4202A-1		IGW 4165B
IGC 4703	IGC 4717-1	IGS-4203B		
IGC 4703-1	IGC 4902A	IGS 4203B-1		
IGC 4704	IGE 4003H	IGS 4204		
IGC 4704-1	IGE 4003H-1	IGS 4204-1		
IGC 4705	IGE 4029	IGT 4102		
IGC 4706A	IGS 4111			

(4) CRANKING MOTORS.

Group 1			Group 2	Group 3
MAB 4071	MAY 4114B	MBY 4001	MAS 4003	MBD 4007
MAB 4082	MAY 4132	MZ 4059	MAS 4009	MBD 4007A
MAU 4006	MAY 4133	MZ 4059A	ML 4209	MBD 4007B
MAW 4029	MAY 4137	MZ 4089A	ML 4211	MBD 4008
MAX 4041	MAY 4138	MZ 4113	MR 4104	MBD 4010
MAY 4114A	MAY 4141	MZ 4115		MBD 4010A

(5) IGNITION COILS.

CE 4645	CM 4001	CM 4012	IG 4065	IG 4070Q
CE 4654	CM 4002	CM 4013	IG 4070H	IG 4092
CF 4001	CM 4006	CO 4001	IG 4070J	IG 4652
CF 4003	CM 4007	CO 4002	IG 4070L	IG 4661
CF 4009	CM 4010	CP 4001	IG 4070P	IG 4801
CF 4013A				

(6) SWITCHES.

Group 1		Group 2	
SW 2677A	SW 4015	SS 4001	SS 4210
SW 2813	XA 456	SS 4022	SS 4505
SW 4001	XA 532	SS 4205	WSE 4001
SW 4002	XA 570	SS 4209	WSE 4002
SW 4011	XA 572	SS 4209A	WSE 4003
SW 4013			

(7) WINDSHIELD WIPERS.

28338	28938	29078	29180	29308
28474	28942	29118	29192	29366
28533	29058	29150		

(8) HORNS.

HA 4001	HA 4032A	HD 4001	HD 4017	HD 4017A
HA 4032				

(9) BOOSTER COIL.

BC 4001

(10) FILTERS AND SHIELDING.

SP 1524	SP 2545	SP 4017	XA 600	XA 665
SP 1525	SP 2546	SP 4018	XA 615	XA 671
SP 1547	SP 2547	XA 586	XA 636	XA 686
SP 1569	SP 3545	XA 599	XA 643	

(11) SPECIAL SOLENOIDS.

SS 4506	SSL 4001	WS 4001	WSA 4001	WSC 4001
SSH 4001	SSL 4002	WS 4002	WSA 4001A	WSF 4001
SSK 4001	SSL 4002A			

For SP 4022 assembly see GDJ 4804B generator and VRH 4104B-1 regulator.

For SP 4022B assembly see GDJ 4804C generator and VRH 4104B-1 regulator.

For SP 4027 assembly see GFZ 4801A generator and VAL 4101A regulator.

For SP 4027B assembly see GFZ 4801B generator and VAL 4101A regulator.

b. Detailed instructions for the removal and installation of the above components are given in the pertinent using arm technical manual.

c. The information and instruction in this manual is supplementary to those in the field and technical manuals prepared for the using arm. This manual does not contain information which is intended primarily for the using arm, since such information is available to ordnance personnel in using arm technical manuals and bulletins.

2. ARRANGEMENT OF MANUAL.

a. The detailed arrangement of material is shown in the Table of Contents. The specifications for fits, tolerances and performance, if any, are listed at the end of each chapter or section. A complete tabulation of the specifications for all equipment is given in chapter 7. Special tools required for all assemblies are listed in chapter 8.

CHAPTER 2

GENERATORS

Section I

GENERATORS—BASIC PRINCIPLES

3. DESCRIPTION.

a. Construction. Generators consist of four main subassemblies or components, namely: the frame and field, the armature, the commutator end head, and the drive end head. The frame and field is composed of the pole shoes, the field coils and the frame, which supports the main components of the generator. The field coils supply the magnetic field which is necessary to generate electricity. The pole shoes and frame supply the path for the magnetic field. The armature consists of a laminated iron core fixed to a shaft and the copper windings which are wound in slots in the core. The ends of these windings are connected to the commutator which consists of a number of copper segments that are insulated from each other and from the core and shaft. The commutator end head is a cast iron head that closes one end of the frame and supports one of the armature bearings. The commutator end head also supports the brush holders and brushes that contact the commutator and carry the electricity from the revolving armature. The drive end head closes the drive end of the frame and also supports a bearing for the armature shaft.

b. General Description.

(1) Generators differ as to the design of the above parts due to the different electrical and mechanical characteristics desired for particular installations. The size, type mounting, type of drive, or the voltage and current output differ but all generators include the four components just described.

(2) Generator part number is stamped on the name plate which is riveted to the frame or cover band. All reference to individual units is made according to this part number.

4. THEORY AND OPERATION.

a. Theory. Electricity is generated when an electrical conductor is moved through a magnetic field. The amount of electricity is determined by the strength of the magnetic field and the speed, size and number of conductors moving through the field. The size and number of conductors is fixed by the design of the generator and the speed is determined by engine conditions. The strength of the field can be varied by changing the amount of current flowing through the field coils. It is by means of this last characteristic that generator regulation is obtained.

b. Operation.

(1) When the generator armature revolves, its conductors cut through the magnetic field supplied by the field coils. This generates electricity in each of the armature conductors. Due to the reversal process in a revolving armature each conductor generates electricity first in one direction then in the other. The commutator and brushes act to reverse the connections of each armature conductor at the proper instant to offset the reversal due to the revolving action. This results in a direct current at the generator terminal.

(2) The field excitation current is self-supplied by the generator. When the generator is stopped there is no field current but there is a slight residual magnetism in the pole shoes. This residual magnetism is sufficient to start the generating process which in turn increases the field coil strength and therefore the generated electricity. This building up of the generator output continues until it reaches the point where the regulating action begins to control the field current.

CHAPTER 2

GENERATORS (Cont'd)

Section II

GENERATORS—GROUP 1

5. DESCRIPTION AND DATA.

a. Description.

(1) Group 1 generators are two pole, three brush units, with the output controlled by the third brush. Some of the generators are used with a two charge regulator which reduces the output when the maximum is not needed. Figure 1 is a disassembled view of a typical group 1 generator showing the main components and their attaching parts. Figure 2 is a disassembled view of a group 1 generator with a distributor drive housing.

(2) Third brush control of the output uses the principle of armature reaction to control the output. The field coil excitation is taken from the armature by the third brush. The position of the third brush is designed to take advantage of the reduction in output over part of the windings as generator speed is increased. Due to the action of the third brush the output increases until a maximum is reached and then is reduced as the speed is increased further. Figure 3 illustrates a typical third brush generator output curve.

(3) The third brush-action is typical of all three brush generators whether used with or without a regulator. A regulator is used to reduce the output when it is not needed and does not increase the output above the amount controlled by the third brush (fig. 3).

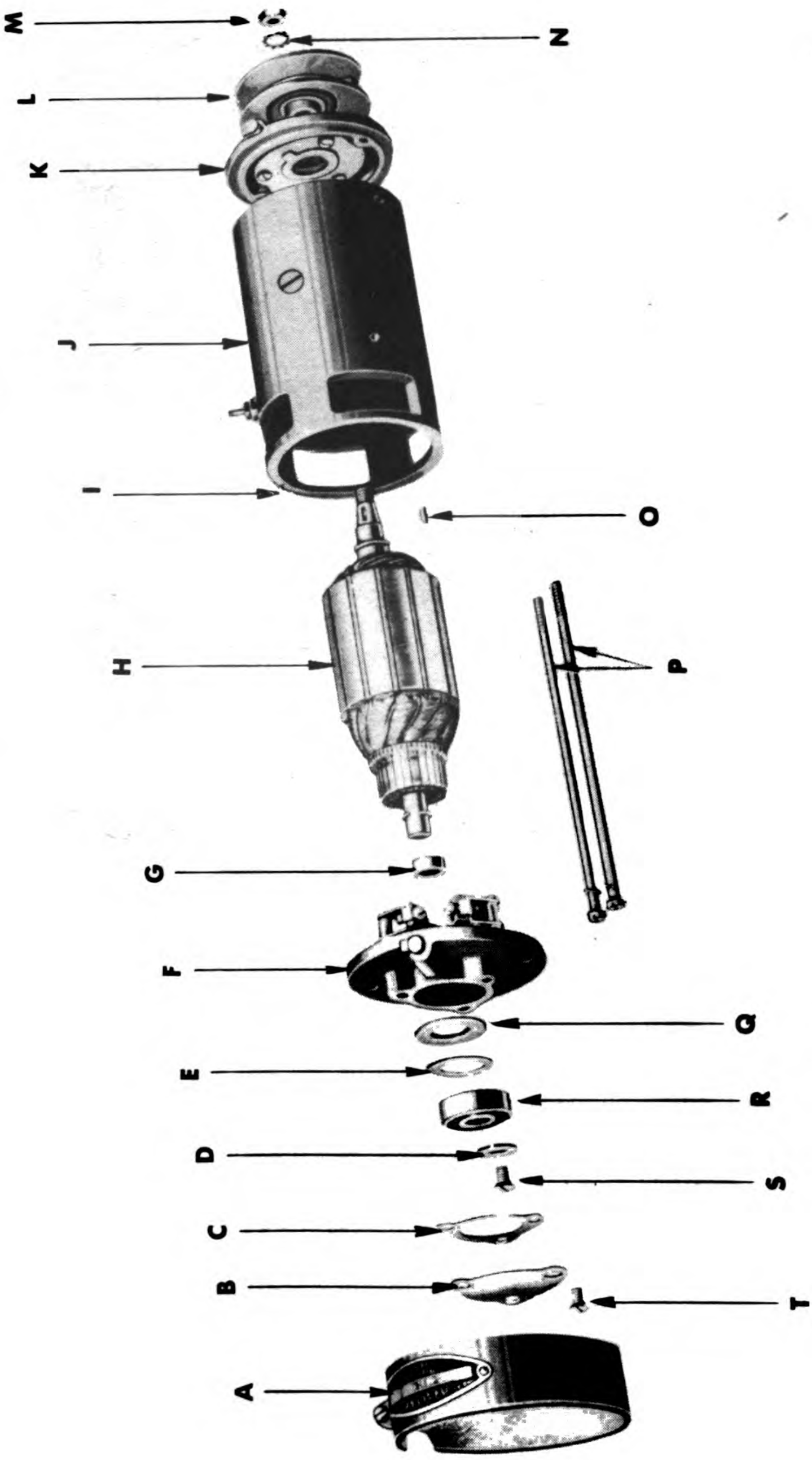
(4) For model numbers of Group 1 generators, see paragraph 1.

b. Data.

Rated Volts—6

Ground Polarity—negative

Field Coil Draw—4.1 to 4.5 amperes at 6.0 volts



RA PD 315000

Figure 1—Main Components of GAS-type Generators

GENERATORS—GROUP 1

A—COVER BAND
B—COMMUTATOR END COVER
C—COVER GASKET
D—BEARING RETAINING WASHER
E—FELT RETAINING WASHER
F—COMMUTATOR END HEAD ASSEMBLY
G—ARMATURE SHAFT SPACER
H—ARMATURE
I—END HEAD LOCATING DOWEL
J—FRAME AND FIELD ASSEMBLY
K—DRIVE END HEAD ASSEMBLY
L—DRIVE PULLEY
M—SHAFT NUT
N—SHAFT LOCK WASHER
O—WOODRUFF KEY
P—THROUGH BOLTS
Q—FELT WASHER
R—COMMUTATOR END BALL BEARING
S—BEARING RETAINING SCREW
T—COVER ATTACHING SCREW

RA PD 315000B

Legend for Figure 1—Main Components of GAS-type Generators

Generator	Rotation	Control	Field Fuse	Motorizing Draw at 6.0 Volts Amperes	Output	
					Volts	Max Amps
GAS 4151	CW	CO	None	5.3 to 5.9	8.0	07.1*
GAS 4166	CCW	CO	None	5.3 to 5.9	8.0	07.1*
GAS 4172	CCW	CO	None	5.3 to 5.9	8.0	07.1*
GDE 4107	CCW	TC	5‡	5.5 to 6.1	8.0	18.0
GDE 4108	CCW	TC	5‡	5.5 to 6.1	8.0	18.0

CW—Clockwise rotation at the drive end.
CCW—Counter-clockwise rotation at the drive end.
CO—Third brush control uses cut-out relay only.
TC—Third brush and two charge regulator control.
*—Do not set output above 12.5 amperes at 8.0 volts.
‡—Fuse located in regulator.

6. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Take out mounting screws, and lift cut-out relay or regulator away from generator frame. Take out lead screws (figs. 4 and 5). Inspect and overhaul regulator or cut-out relay (pars. 43 to 47).

(2) Wipe outside of generator with cloth dampened in dry-cleaning solvent. If distributor mounting housing is mounted on generator, clean out grease and plug hole to prevent dirt from entering. Do not allow dry-cleaning solvent to stand in housing as it will soak bearing, commutator and brushes, and seriously affect generator performance.

b. Inspecting.

(1) Inspect frame, end heads, and drive gear, for wear and cracks. If any part is cracked, disassemble generator and install new part (pars. 7 and 11). If drive pulley is cracked, bent or the belt surface is rough, install new pulley (pars. 7 k, 7 l and 11 l). Generator and distributor drive gears (if used) must be in good condition with no teeth missing or damaged. Gears will operate satisfactorily with some wear; however, install new gears if wear is not distributed evenly over all teeth or if excessive wear is evident.

(2) Take out clamp screw and lift cover band from generator.

(3) Lift brush arm with hook and inspect brushes. Install new brushes if oil soaked or worn to less than 3/8 inches in length. To install new brushes, loosen brush screw and slip brush off screw (fig. 6).

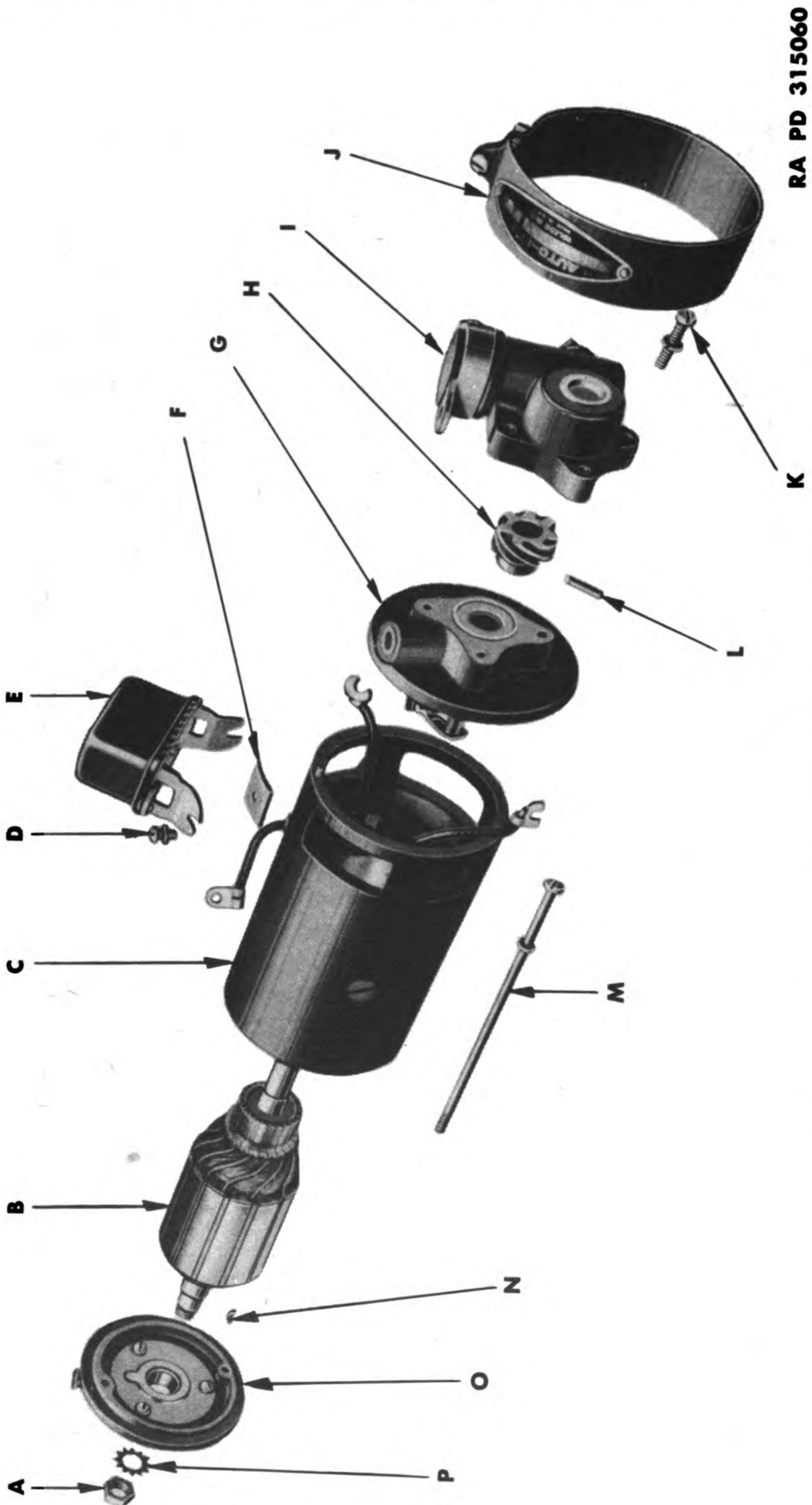


Figure 2—Main Components of GDE-type Generators

A—SHAFT NUT
B—ARMATURE
C—FRAME AND FIELD
D—CUT-OUT RELAY MOUNTING SCREW
E—CUT-OUT RELAY
F—CUT-OUT RELAY MOUNTING SPACER
G—COMMUTATOR END HEAD
H—DISTRIBUTOR DRIVE GEAR
I—DISTRIBUTOR MOUNTING HOUSING
J—COVER BAND
K—DISTRIBUTOR HOUSING ATTACHING SCREW
L—DISTRIBUTOR GEAR RIVET
M—THROUGH BOLT
N—WOODRUFF KEY
O—DRIVE END HEAD
P—SHAFT LOCK WASHER

RA PD 315060B

Legend for Figure 2—Main Components of GDE-type Generators

Install new brush on screw and tighten to hold brush in place. Make sure brush is turned so that beveled face fits commutator. If brush holders are gummy, dirty, or corroded, disassemble and clean generator (pars. 7 and 8). If brush arm does not swing freely, overhaul generator (pars. 7 to 13). Inspect alinement of brushes on commutator. If edges of brushes are not in perfect alinement with commutator segments, inspect for incorrect brush assembly and for bent or distorted brush arms. Loosen brush screw and straighten brush, if necessary, and overhaul generator if arms are bent or distorted (pars. 7 to 13).

(4) If commutator is rough or worn, disassemble generator and turn down commutator (par. 10 **b**). If commutator is only dirty, clean by holding 2/0 flintpaper against it while turning armature slowly. Blow sand out of generator with clean dry compressed air.

c. Testing.

(1) MEASURE FIELD COIL DRAW (fig. 7).

(a) Mount generator on test stand.

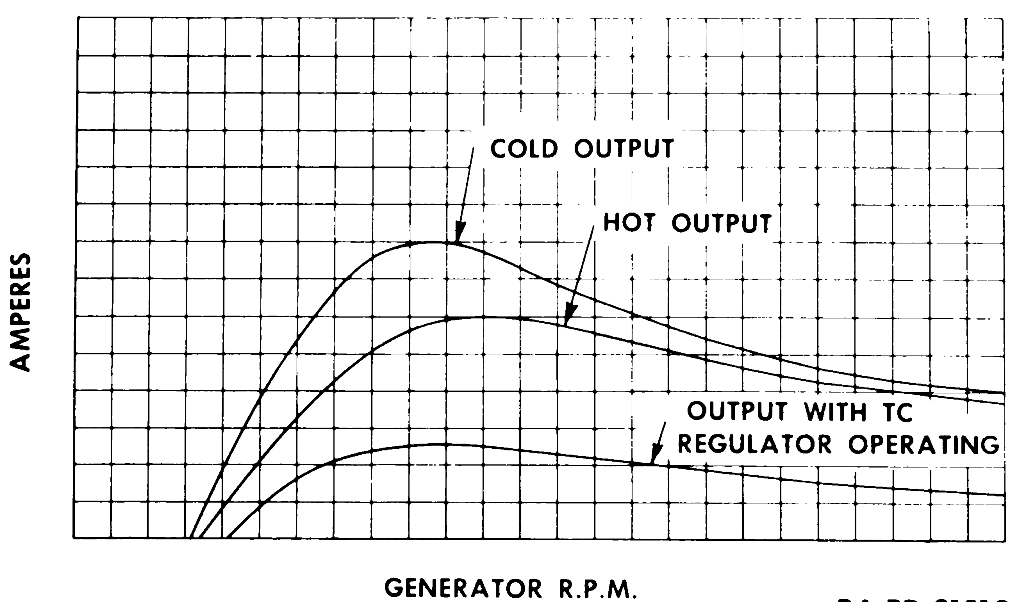


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Figure 3—Typical Output Curve of Group 1 Generators

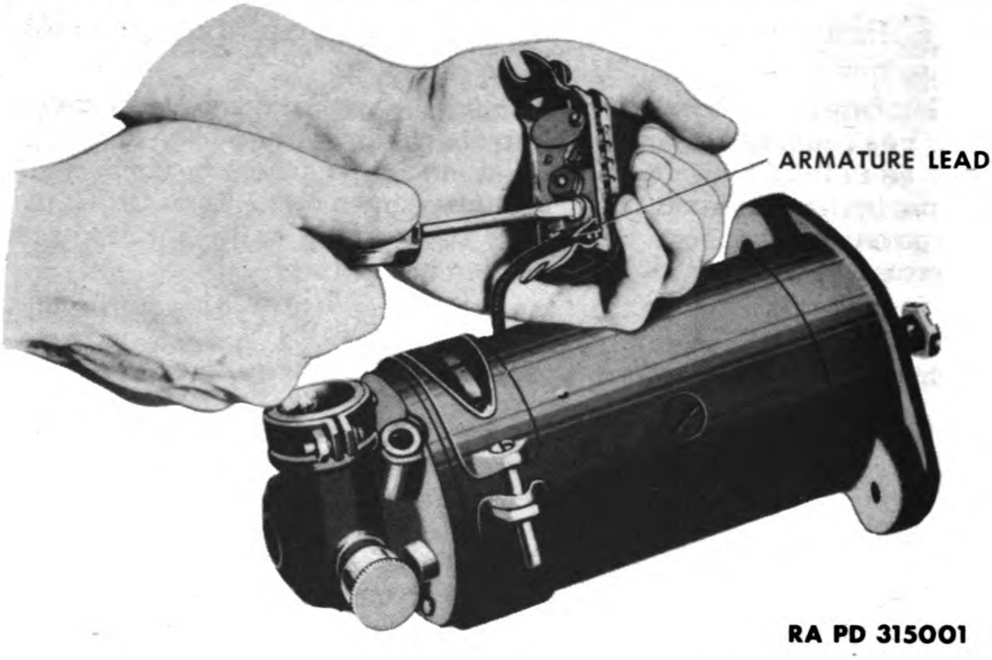

Figure 4—Disconnecting Armature Lead from Cut-out Relay

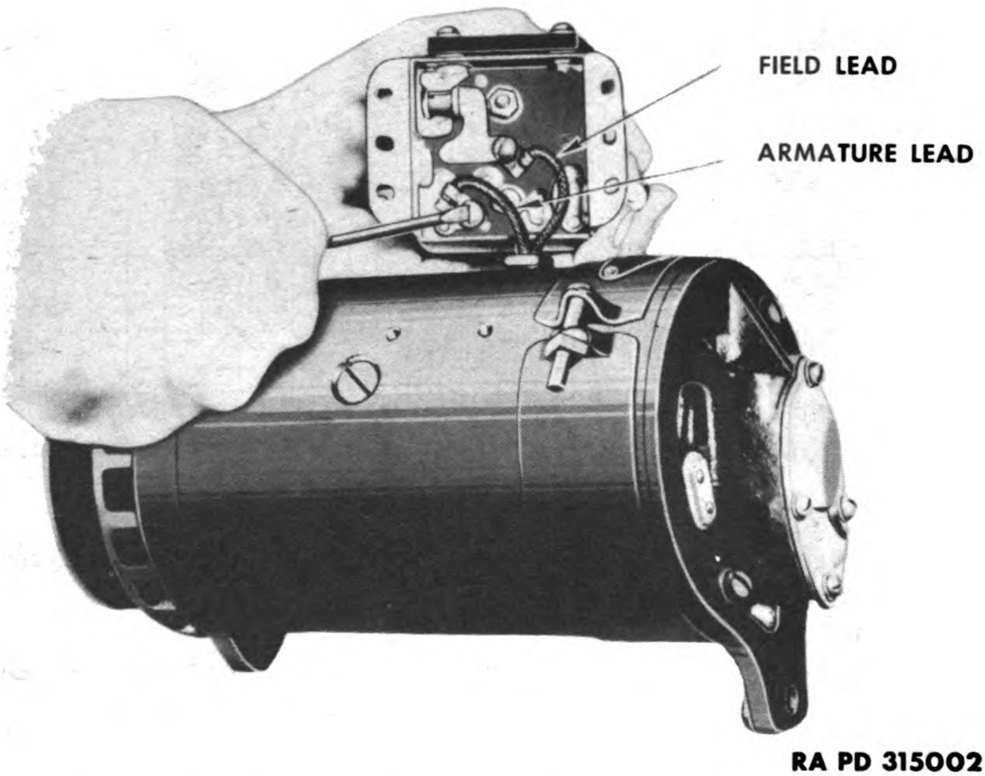

Figure 5—Disconnecting Armature Lead from Regulator

GENERATORS—GROUP 1

(b) Insert small piece of paper under third brush to insulate brush from commutator.

(c) Test stand battery must be fully charged and of same rated voltage as generator. Connect voltmeter lead and one test stand battery lead to third brush terminal. On GAS-type generator connect remaining battery and voltmeter leads to frame of generator. On GDE-type generators connect the second battery and voltmeter leads to generator field terminal.

(d) Close test stand battery switch and adjust rheostat until voltage is 6.0 volts. The current must be between 4.1 and 4.5 amperes. Overhaul generator if current is not within limits (pars. 7 to 13).

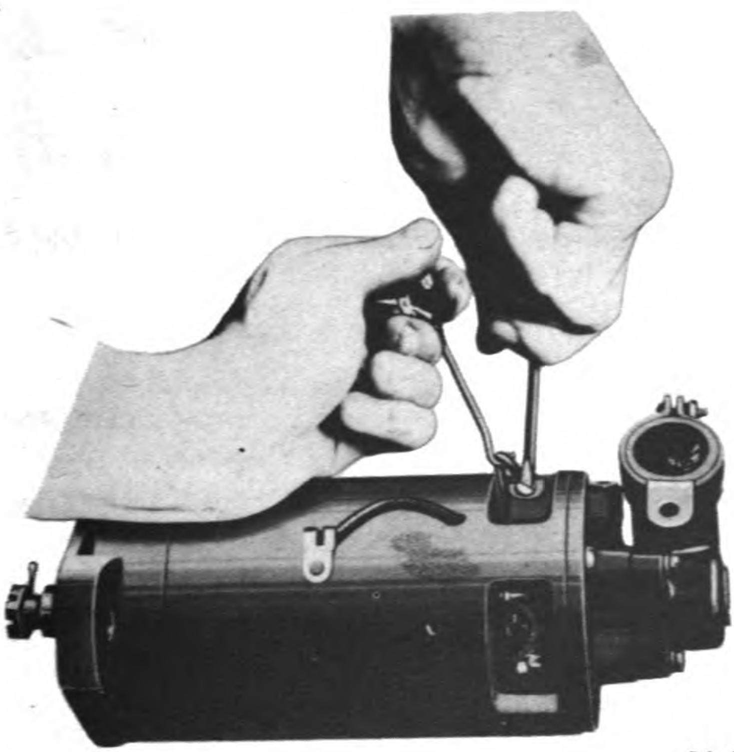

Figure 6—Removing Brush and Brush Lead on Group 1 Generators

(e) Open test stand battery switch.

(f) Disconnect leads from generator and remove paper from under third brush.

(2) MEASURE MOTORIZING DRAW (fig. 7).

(a) Connect six-volt battery to test stand for negative ground polarity.

(b) Connect battery ground lead to generator frame and connect other battery lead to generator armature terminal or lead.

(c) Connect voltmeter from generator frame to generator armature terminal or lead.

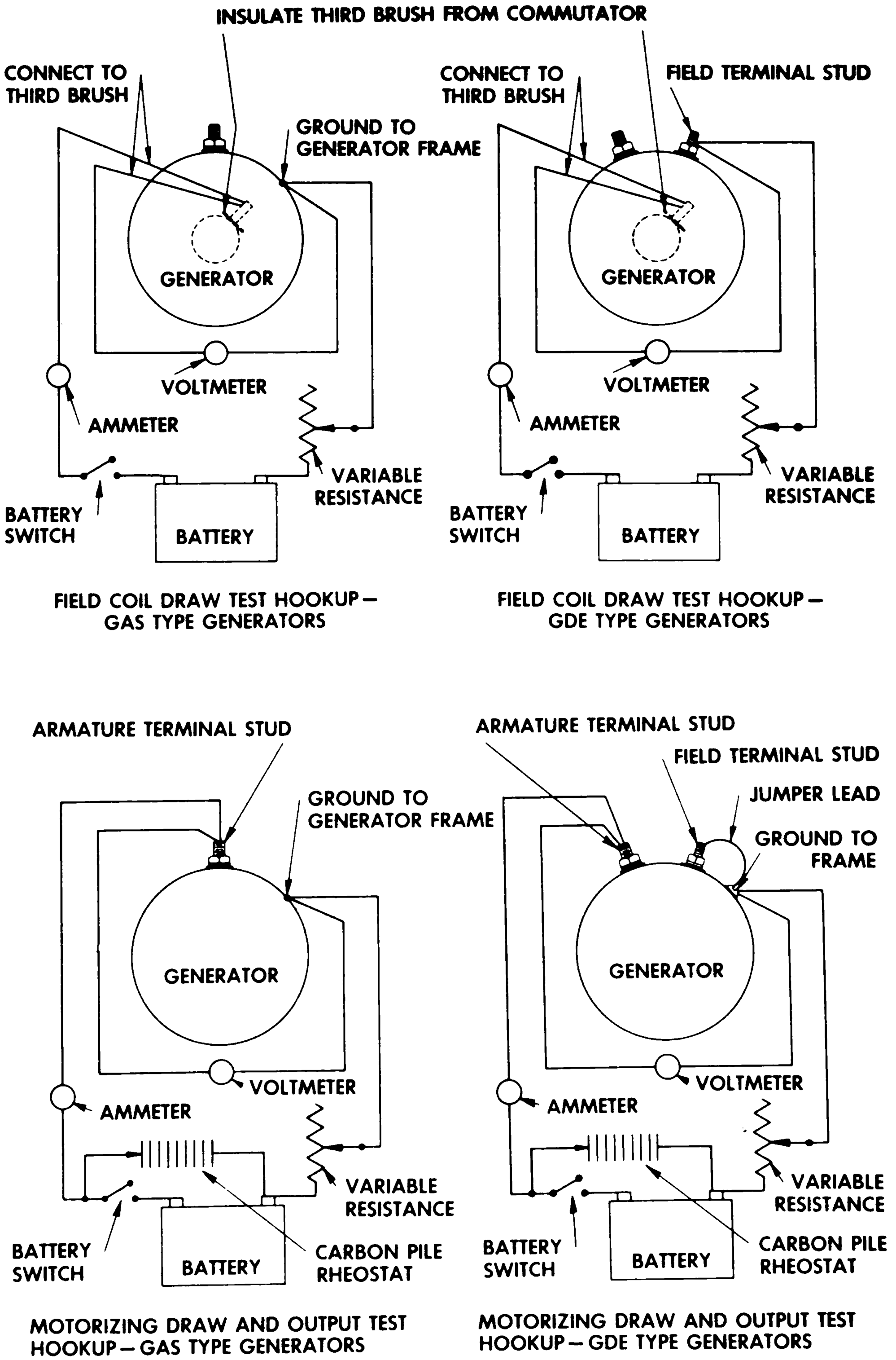

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Figure 7—Test Hookups for Group 1 Generators

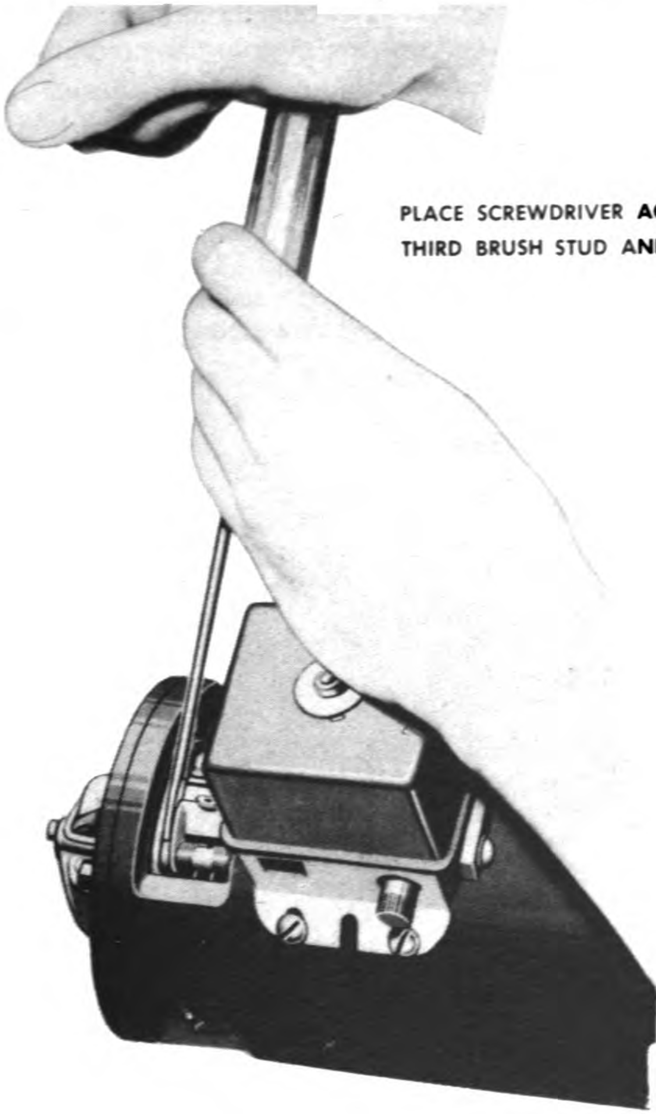


Figure 8—Adjusting Position of Third Brush

(d) On GDE-type generators, ground field terminal to generator frame with short lead.

(e) Close generator test stand battery switch. The generator must operate as a motor with armature turning slowly.

(f) Adjust voltage to 6.0 volts and read ammeter. If current is not within specifications (par. 5 **b**) or if armature does not turn it indicates worn bearings, incorrect bearing alinement, shorts or improper generator assembly. Overhaul generator if current is incorrect (pars. 7 to 13).

(g) Open test stand battery switch.

(3) CHECK GENERATOR OUTPUT (fig. 7).

(a) With generator connected as above for motorizing test, connect armature shaft to test stand driving motor with coupling.

(b) Close test stand battery switch.

(c) Start test stand motor so that generator is driven in direction specified (par. 5 **b**).

(d) Increase speed slowly keeping voltage at 8.0 volts by adjusting load rheostat across battery. Voltage must be held at 8.0 volts. Note ammeter reading as speed is increased. The current output of generator will increase to a maximum value and then will decrease as speed is increased further. Note maximum current output.

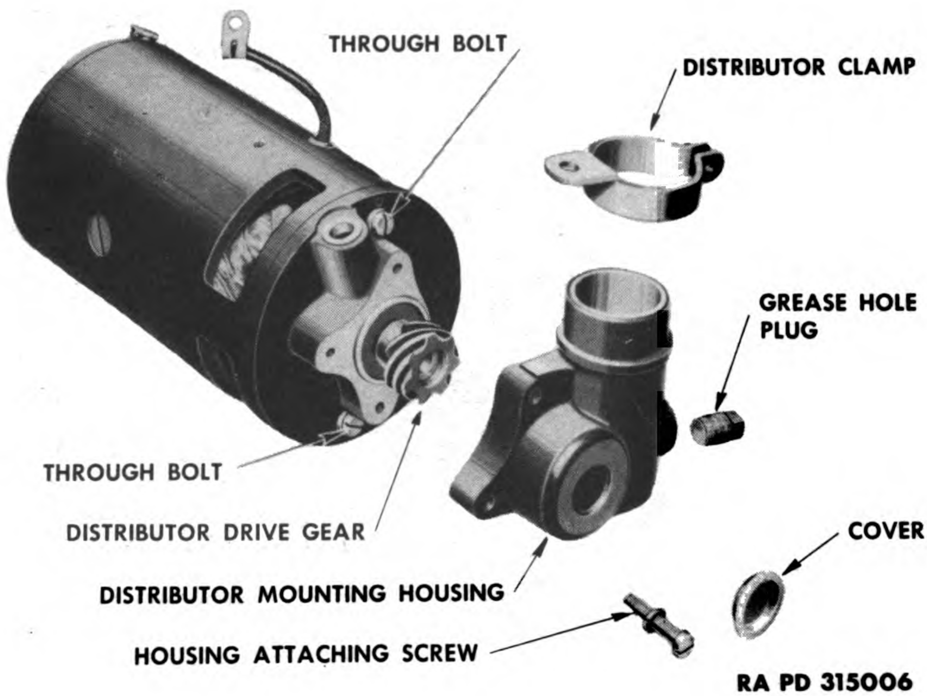


Figure 9—Commutator End Construction of GDE-type Generators

(e) Adjust maximum output to figure specified (par. 5 **b**) by moving third brush; place screwdriver against base of brush holder stud and tap lightly to move brush (fig. 8). Moving third brush in direction of armature rotation increases maximum output while moving third brush against direction of rotation reduces output.

(f) After new brushes have been installed, operate generator at near maximum output (par. 6 **c** (3) *(d)* above) for 15 to 30 minutes to make sure of a perfect brush fit on commutator.

(g) Allow generator to cool to room temperature, then check and adjust the maximum output (par. 6 **c** (3) *(d)* and *(e)* above). If necessary to adjust output while generator is hot, set output 3 amperes below maximum figure specified for a cold generator.

(h) The ampere output tabulated in specifications (pars. 5 b and 13 c) for GAS-type generators is the value that is found to be the average current needed for that particular installation. If more output is needed adjust maximum current at any setting up to 12.5 amperes at 8.0 volts.

(i) If specified output cannot be obtained by adjusting third brush look for high resistance connections, poor brush contact, dirty commutator, worn or oil soaked brushes, or improper brush plate assembly. If any of the above conditions are present disassemble and overhaul generator (pars. 7 to 13).

(4) LUBRICATION.

(a) Add three to five drops of engine oil (SAE 30) to each oiler and repack distributor drive housing with ½ ounce of high temperature

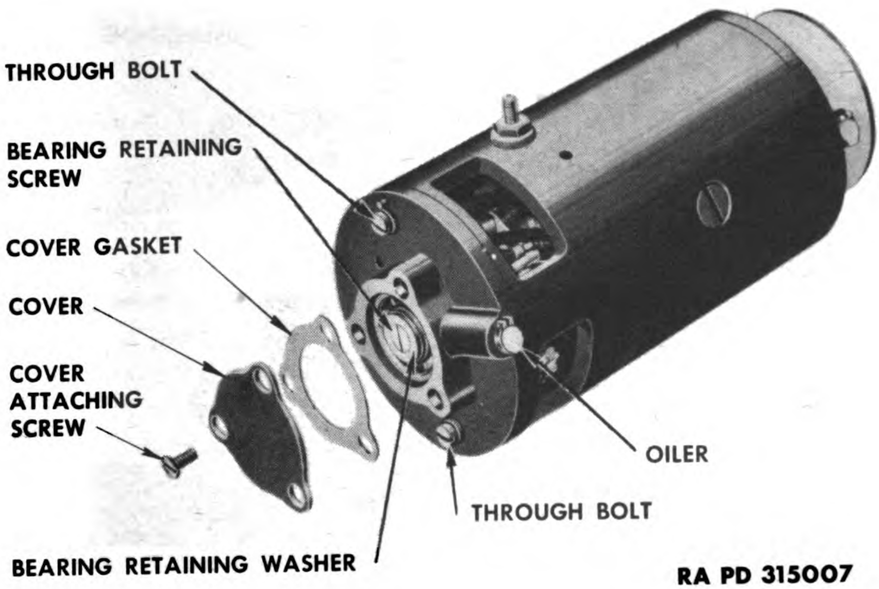


Figure 10—Commutator End Construction of GAS-type Generators

grease. Plug hole in housing with cork to prevent dirt from entering while storing or shipping.

(b) Install cover band on generator making sure inspection holes are covered. Install and tighten clamp screw and nut.

(c) On GAS-type connect lead to the "A" terminal on bottom of cut-out relay and on terminal stud types connect other end of lead to terminal stud. Assemble spacers between cut-out relay and frame and install mounting screws and lock washers. Tighten screws.

(d) On GDE-type connect lead to terminal marked A on bottom of regulator and connect other end of this lead to stud marked A. Connect lead to terminal marked F on bottom of regulator and other end of this lead to stud marked F. Mount regulator on frame and install and tighten spacers, mounting screws, and lock washers.

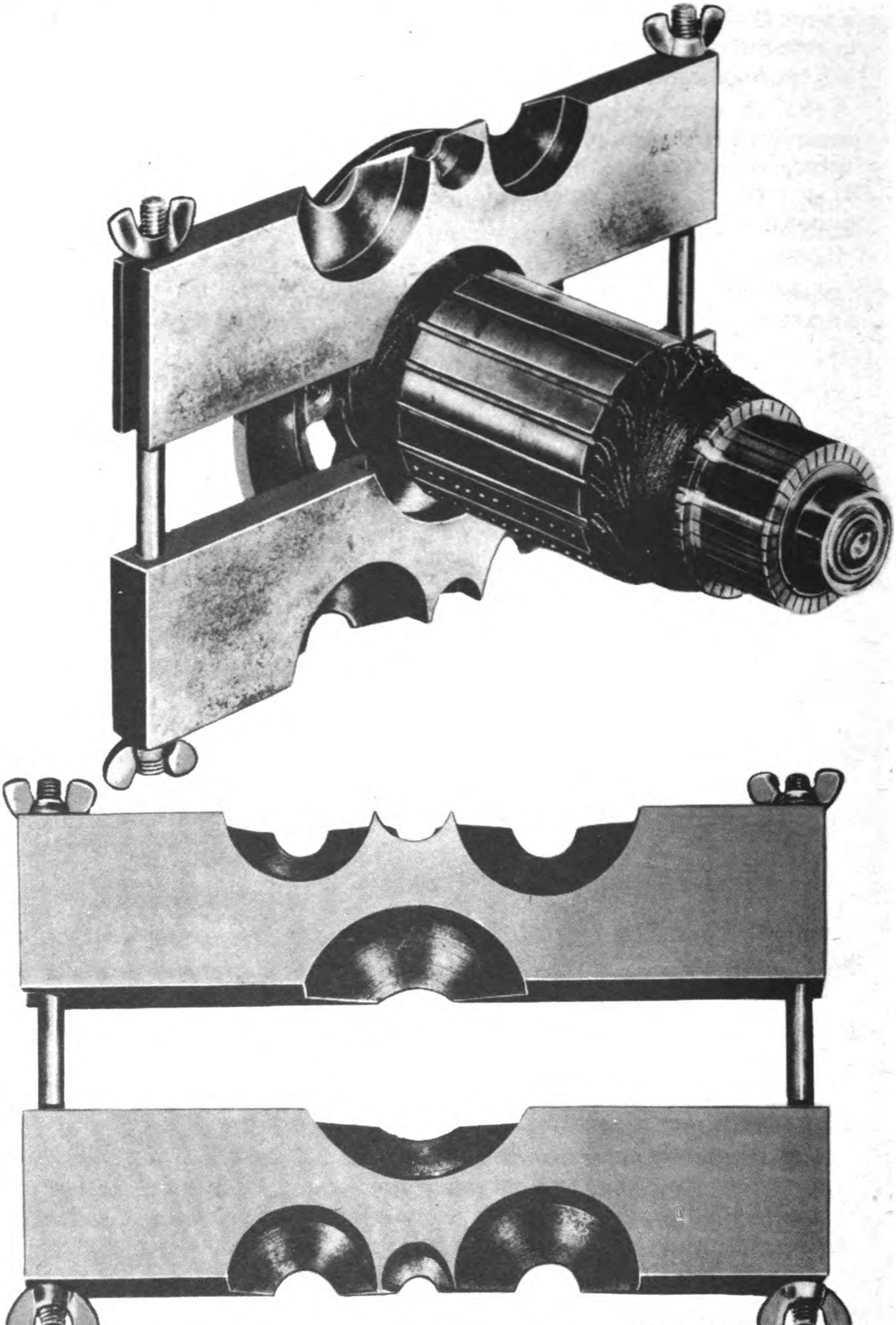


Figure 11—Armature with Arbor Press Plate in Position for Bearing Removal

7. DISASSEMBLY.

a. Remove Regulator or Cut-out Relay.

(1) Take out mounting screws, lock washers, and spacers.

(2) Lift cut-out relay or regulator away from generator frame and remove lead screws (figs. 4 and 5). Inspect circuit breaker or regulator (pars. 43 to 47).

b. Remove Cover Band. Remove clamp screw and pull band from generator.

c. Remove Brushes and Disconnect Leads. Loosen brush screw, disconnect leads, and slide brushes off screw (fig. 6).

d. Remove Distributor Mounting Housing. (If pertinent) (fig. 9).

(1) Remove attaching screws.

(2) Remove housing and gasket.

e. Remove Distributor Gear. (If pertinent) (fig. 9).

(1) Remove rivet from gear. Do not damage gear or shaft.

(2) Slide gear off shaft.

f. Remove Commutator End Cover. (If pertinent) (fig. 10).

(1) Remove attaching screws.

(2) Lift off cover and gasket.

g. Remove Commutator End Shaft Screw. (If pertinent). Take out screw and plain washer (fig. 10).

h. Remove Through Bolts. Unscrew both bolts and remove from generator (figs. 9 and 10).

i. Remove Commutator End Head. Tap commutator end head lightly with soft hammer and lift head from generator. Slide ball bearing, felt washers, and felt retainer, from head. Do not remove bronze bearing if used.

j. Remove Armature and Drive End Head. Tap drive end head lightly with soft hammer and pull armature and drive end head out of frame and field.

k. Remove Shaft Nut. Mount armature in padded vise and remove nut and washer from drive end of shaft.

l. Remove Drive Pulley or Gear.

(1) Pull generator drive pulley or gear from shaft.

(2) Remove Woodruff key from shaft.

m. Remove Drive End Head.

(1) On GAS 4172 and GDE 4108 remove lock nut.

(2) Press armature shaft out of drive end head (fig. 11).

8. CLEANING OF COMPONENTS.

a. Frame and Field Assembly. Thoroughly clean frame and field assembly with cloth dampened in dry-cleaning solvent. Do not soak in dry-cleaning solvent and be careful not to damage insulation or leads. Blow dry with clean dry compressed air.

b. **Armature.** Blow all loose dirt off with compressed air. Wipe armature with clean cloth dampened in fresh dry-cleaning solvent. Sand commutator with 2/0 flintpaper. Do not handle commutator. Clean dirt from between commutator bars but do not damage or form burs on bars or mica.

c. **Commutator End Head.**

(1) Remove brush plate attaching screws and take off brush holder plates.

(2) Soak head and brush holders in dry-cleaning solvent and clean with soft rag. Blow dry with compressed air. Remove all lint.

(3) Wipe brushes with a clean dry rag.

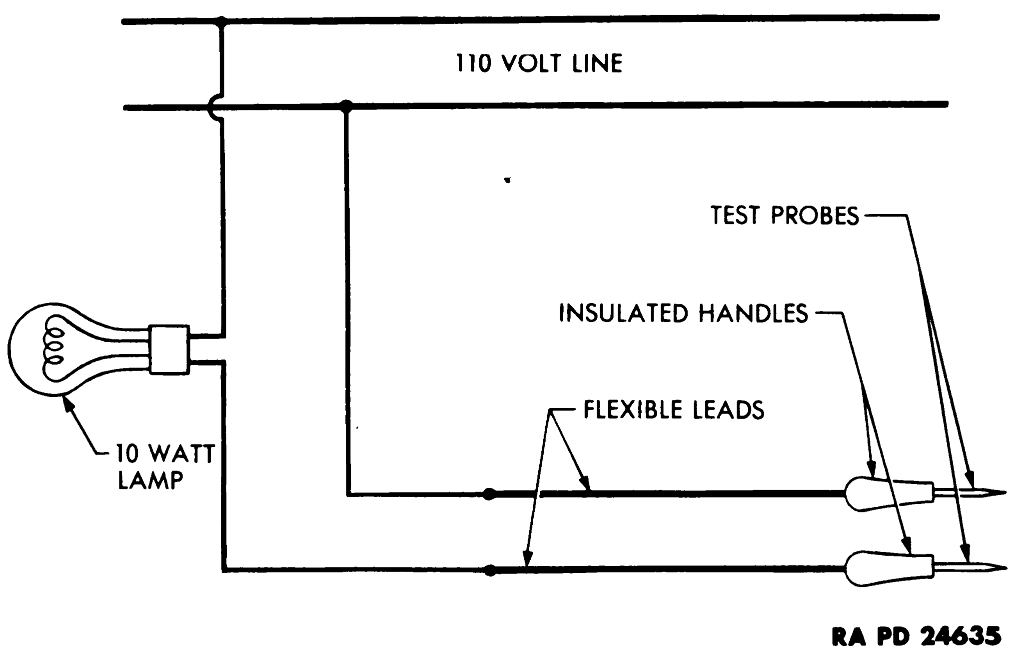


Figure 12—Test Probes

(4) Soak ball bearing in dry-cleaning solvent and clean thoroughly. Blow dry with clean compressed air; do not spin a dry bearing.

(5) Wipe felt washers and wicks clean with rag.

(6) Soak retainers, covers and gaskets, in dry-cleaning solvent and clean and dry thoroughly.

d. **Drive End Head.**

(1) Take out bearing retainer screws and remove retainers, felt washers, and bearing.

(2) Soak head in dry-cleaning solvent and clean with brush. Blow dry with compressed air.

(3) Soak ball bearing in dry-cleaning solvent and clean thoroughly. Blow dry with compressed air but do not spin dry bearing.

(4) Wipe washers and wicks clean with a rag.

(5) Soak retainers and gaskets in dry-cleaning solvent, clean and dry thoroughly.

e. **Miscellaneous Parts.** Clean balance of generator parts in dry-cleaning solvent and dry thoroughly.

9. INSPECTION AND TEST OF COMPONENTS.

a. Frame and Field Assembly.

(1) Inspect frame and field for worn or frayed insulation, broken leads and loose or corroded terminals. If any parts are defective, repair, or install new parts (par. 10 a).

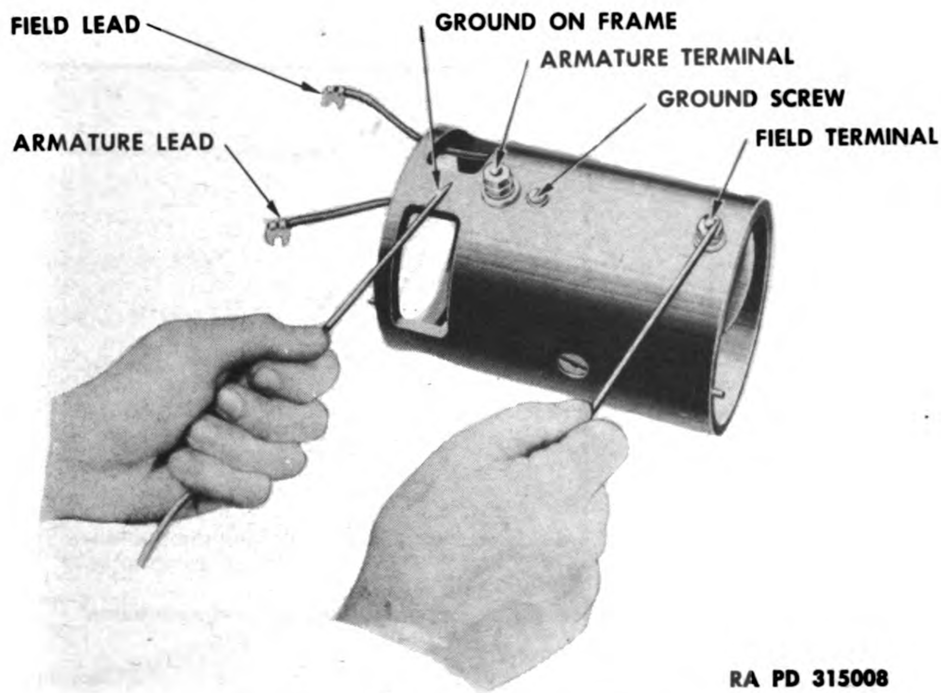


Figure 13—Testing Field Coils for Grounds with Test Probes—GDE-type Generators

(2) Check field coils for grounds with test probes consisting of a lamp in series with two points and a source of electricity (fig. 12). Make sure field coil leads are not touching frame. Touch one test probe to frame and touch the other test probe to field terminal or lead (fig. 13). On GAS-type generators remove field coil ground screw and test from ground lead to frame (fig. 14). If test proves coils to be grounded, remove nuts and washers from field terminal stud and press stud out of frame. Test coils for grounds again. If lamp does not light, it indicates faulty terminal stud insulation which must be replaced (par. 10 a). If coils still prove grounded, unsolder connection between the two coils, test each coil separately and replace grounded coil (par. 10 a).

(3) Touch one test probe to third brush-lead and touch other test probe to field terminal (fig. 15). On GAS-type generators touch second

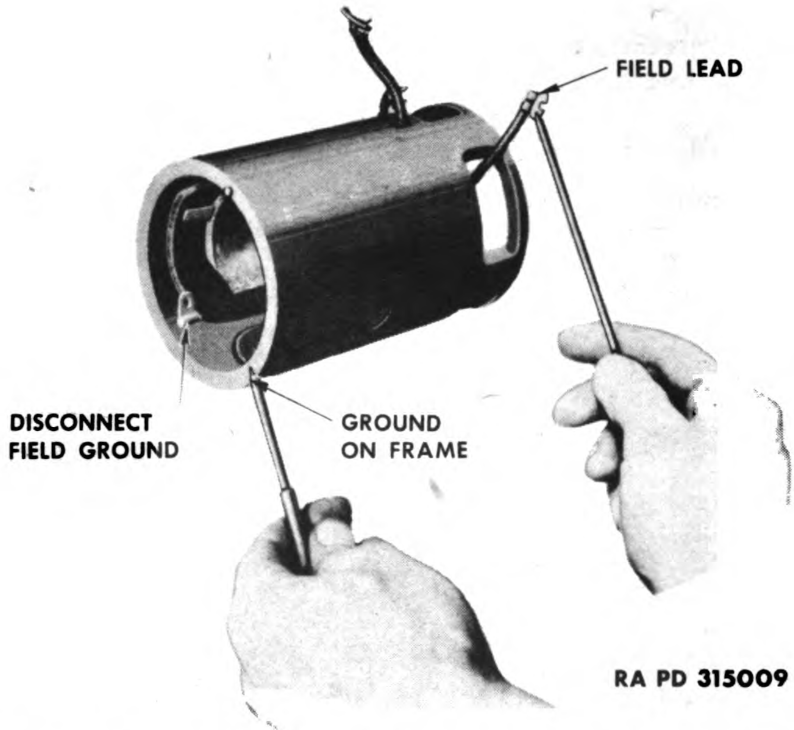


Figure 14—Testing Field Coils for Grounds with Test Probes—GAS-type Generators

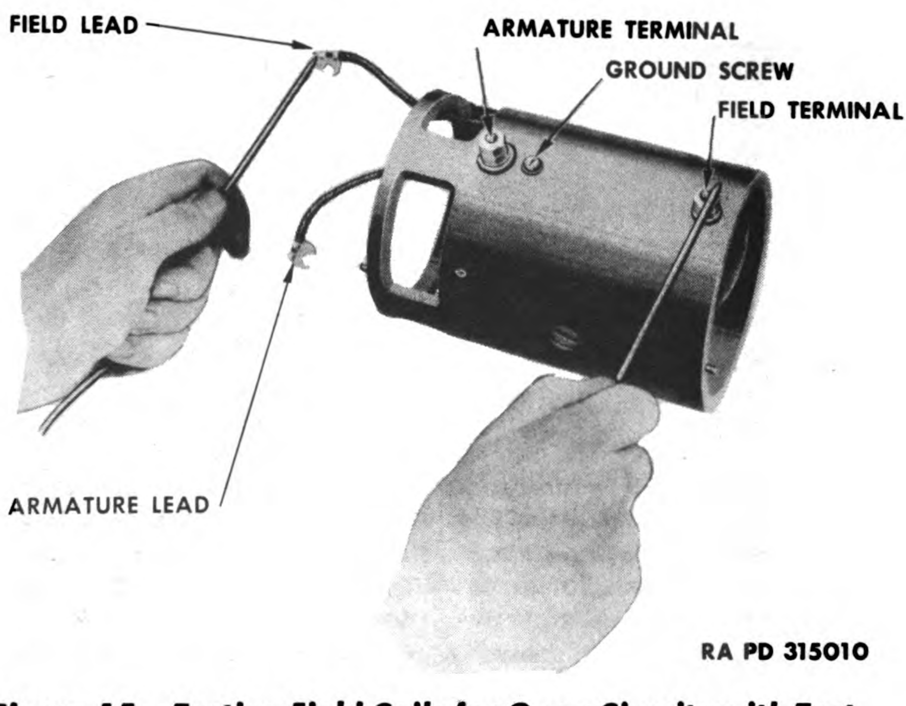


Figure 15—Testing Field Coils for Open Circuits with Test Probes—GDE-type Generators

test probe to field coil ground terminal (fig. 16). If coils test open, check each coil separately by testing across each coil. If either coil is open install new coil (par. 10 a).

(4) Check armature terminal stud and main brush lead for grounds and opens. Make sure leads are not touching frame and touch test probes to frame and to main brush lead. If a ground is present disassemble stud or lead from frame and install new insulation. Touch test probes to the two ends of main brush lead, or to terminal post and

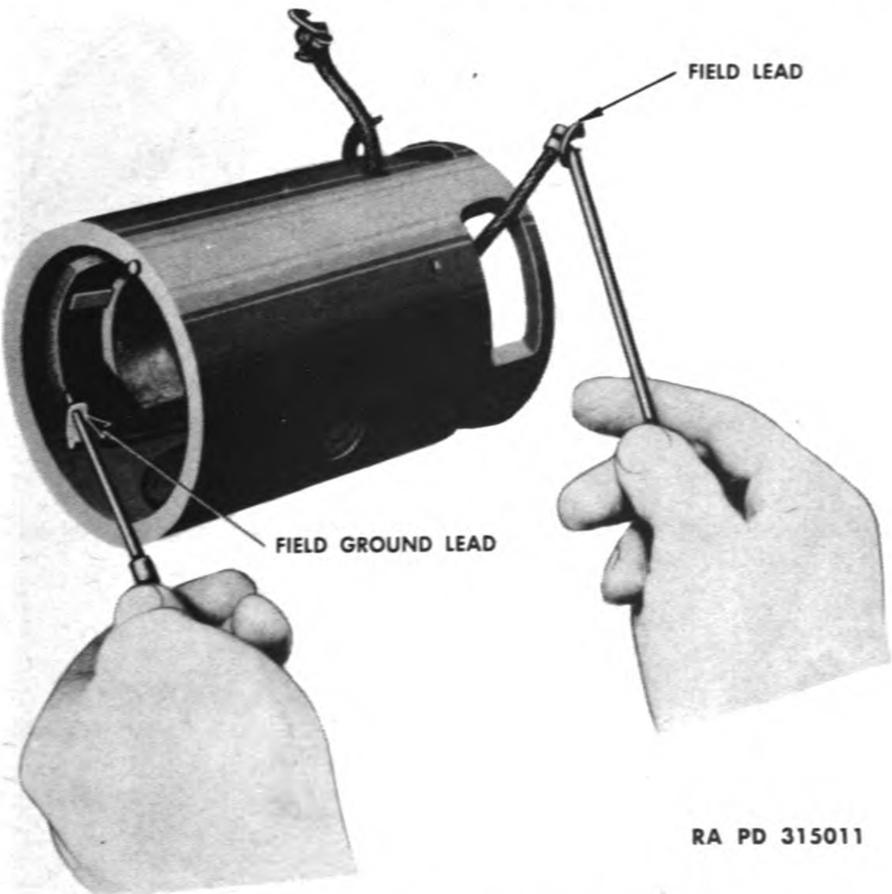


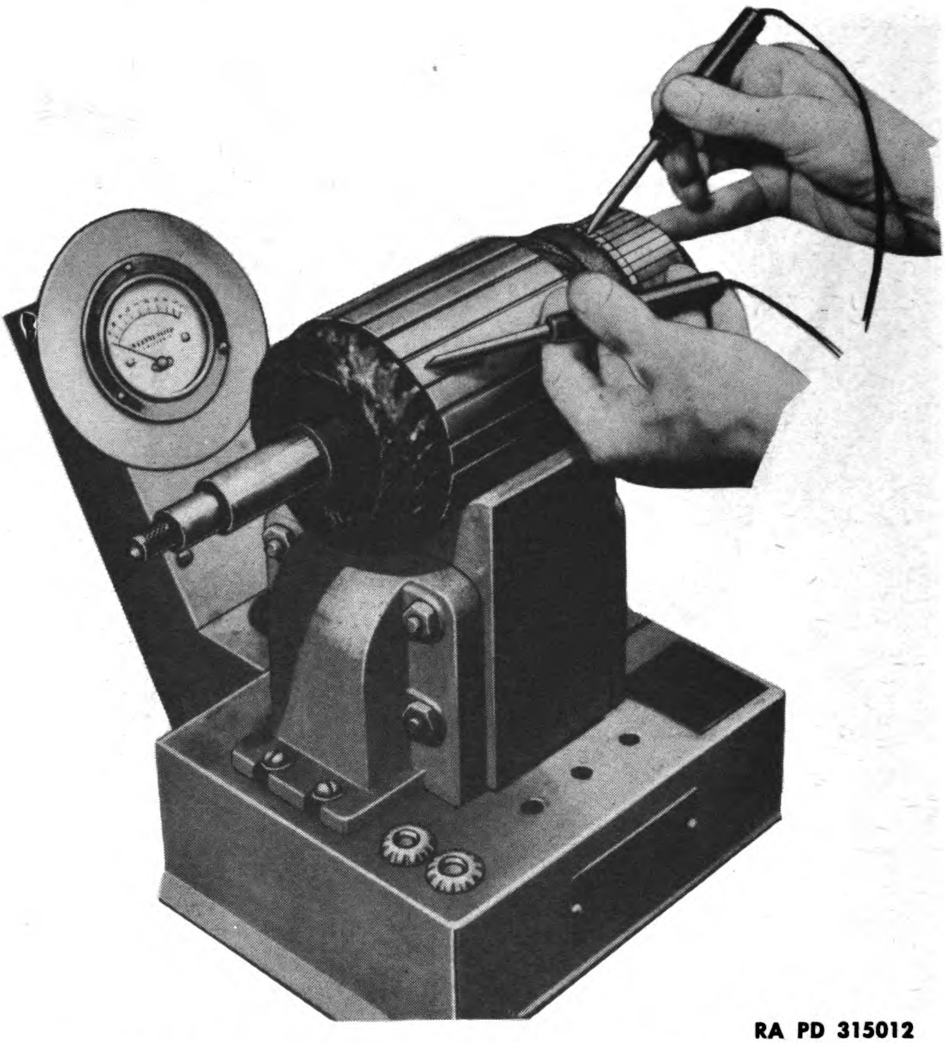
Figure 16—Testing Field Coils for Open Circuits with Test Probes—GAS-type Generators

end of lead on GDE 4107 and 4108 generators. Install new lead if lamp does not light.

(5) Connect ammeter, battery, and variable resistance, in series with the two field coil terminals. Connect voltmeter to the two field coil terminals. Adjust voltage to 6.0 volts and read ammeter. If current is not between 4.1 and 4.5 amperes it indicates a short within a coil. To check which coil is shorted, connect battery, ammeter, and voltmeter across each coil separately. Adjust voltage to 6.0 volts. The current must be twice the current specified for two coils in series or 8.2 to 9.0 amperes. If current is above or below limits coil is shorted and must be replaced (par. 10 a).

b. Armature.

(1) Inspect armature to make sure all coils are properly pressed into core slots and are soldered to commutator risers. Replace armature if windings are loose or unsoldered at the commutator. Inspect core for wear and discard armature if scored badly. Turn down commutator if rough or worn (par. 10 **b**). Inspect bearing seats on shaft for wear and discard armature if wear is evident.



RA PD 315012

Figure 17—Testing Armature Coils for Grounds on Growler (17-G-5940)

(2) Place armature on "V" block and touch one test probe to shaft or core. Touch other probe to each commutator segment in turn (fig. 17). If ground is present, lamp will light. Do not touch probes to bearing or brush surfaces as an arc will mar the smooth finish. Discard armature if grounded.

(3) Touch the two probes to each pair of adjacent commutator

bars. Discard armature if an open circuit is present as indicated by the lamp not lighting. Repeat this test on every pair of adjacent bars.

(4) Place armature on growler and hold thin steel strip on core (fig. 18). Rotate armature slowly through a complete revolution. If a short is present, steel strip will become magnetized and vibrate. Discard armature if shorted.

(5) Place armature with shaft bearing seats on "V" blocks and mount a dial indicator with plunger against commutator (fig. 19).

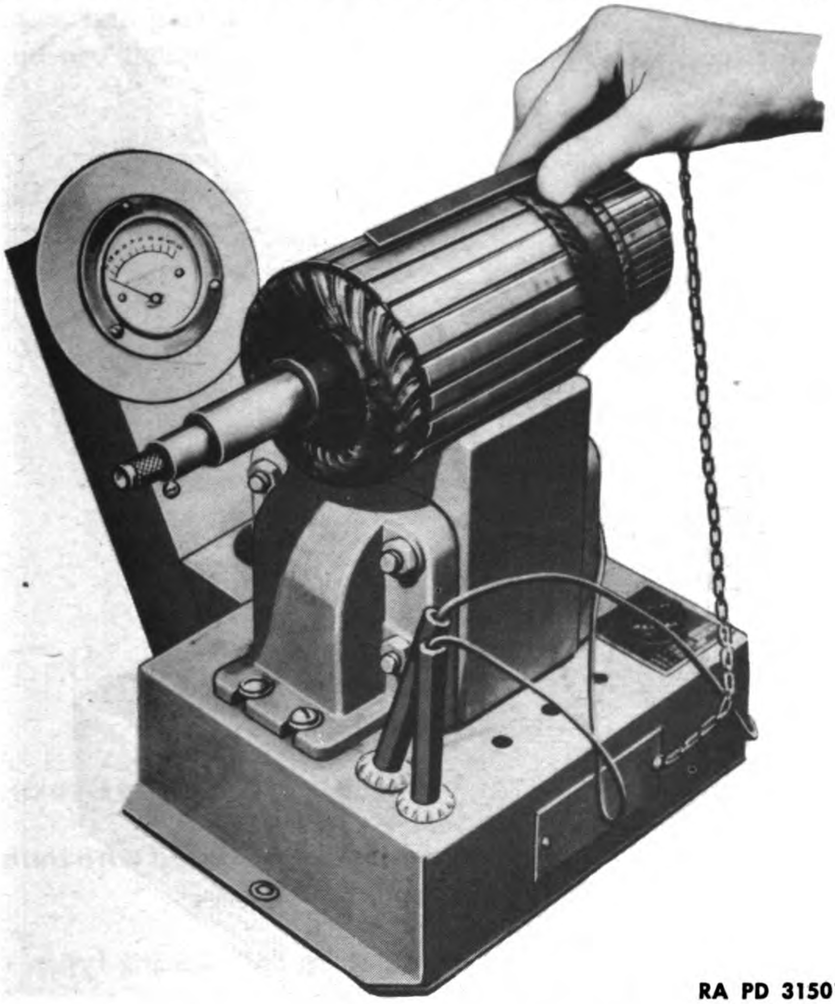

RA PD 315013

Figure 18—Testing Armature Coils for Shorts on Growler (17-G-5940)

Rotate armature and measure total out of round reading. If total reading is larger than 0.0005 inches turn down commutator (par. 10 **b**).

c. Commutator End Head.

(1) Inspect head and parts for cracks and distortion and discard if defective. Replace leads if frayed or broken. Discard felt washers and wicks if torn or gritty. Discard gasket if not in perfect condition. Replace brushes if cracked, oil soaked, or worn to less than 3/8 inches in length.

(2) Install brush plates on head but do not install brushes, felt wick, or cover. Assemble brushes only after head is installed on armature as assembling and removing head from armature may crack and chip brushes.

(3) With test probes check third brush holder and insulated main brush holder for grounds (fig. 20). If ground is present, install new brush plate.

(4) Place armature in padded vise, and install commutator end head on shaft. On ball bearing types, install bearing and washers in head. Feel for side play in bearing. If side movement can be felt it

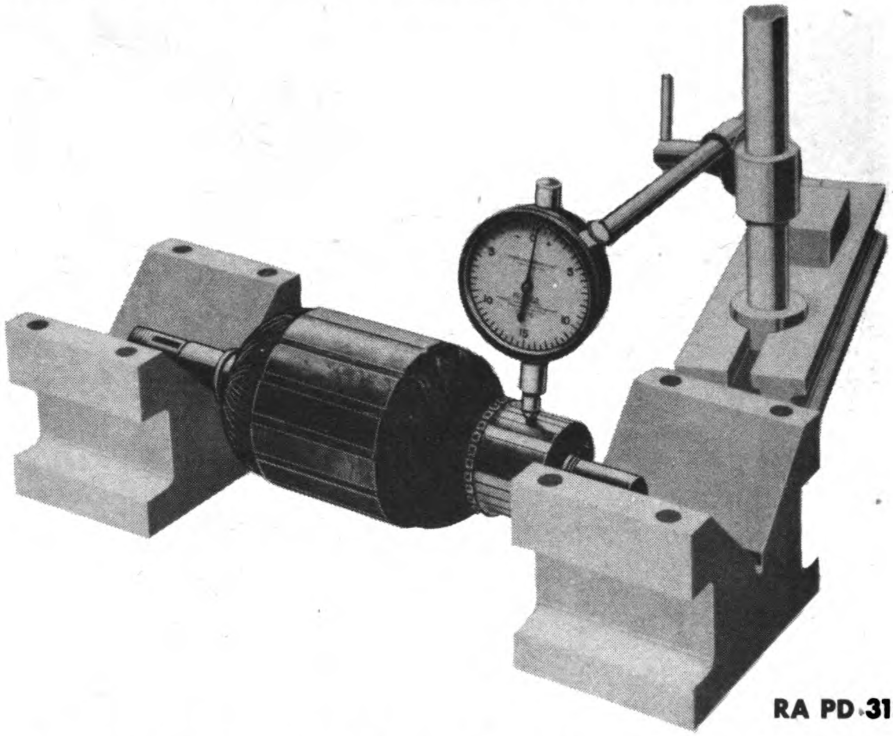


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Figure 19—Measuring Commutator Out-of-round with Indicator (41-I-100) and "V" Blocks

indicates a worn bearing, worn shaft, or on ball bearing types, a loose bearing fit in the head. Inspect to determine cause of side play and install new parts as necessary.

(5) With head assembled on armature, install brushes in their holders. Make sure brushes are correctly and firmly mounted. Install new brush plate if brushes do not swing freely and if edges of brushes are not in perfect alinement with commutator segments.

(6) Hook tension gage under brush, screw tight against brush, and pull on a line parallel to face of brush (fig. 21). Take reading just as brush leaves commutator. To change tension remove brush arm and spring and bend spring. Check and adjust tension for all three brushes to 15 to 20 ounces with new brushes.

(7) Pack ball bearing ½ full with high temperature grease and soak felt washers, wicks and bronze bearing, if used, in engine oil (SAE 30). Do not get oil on brushes or holders and drain off excess oil from bearing and felts.

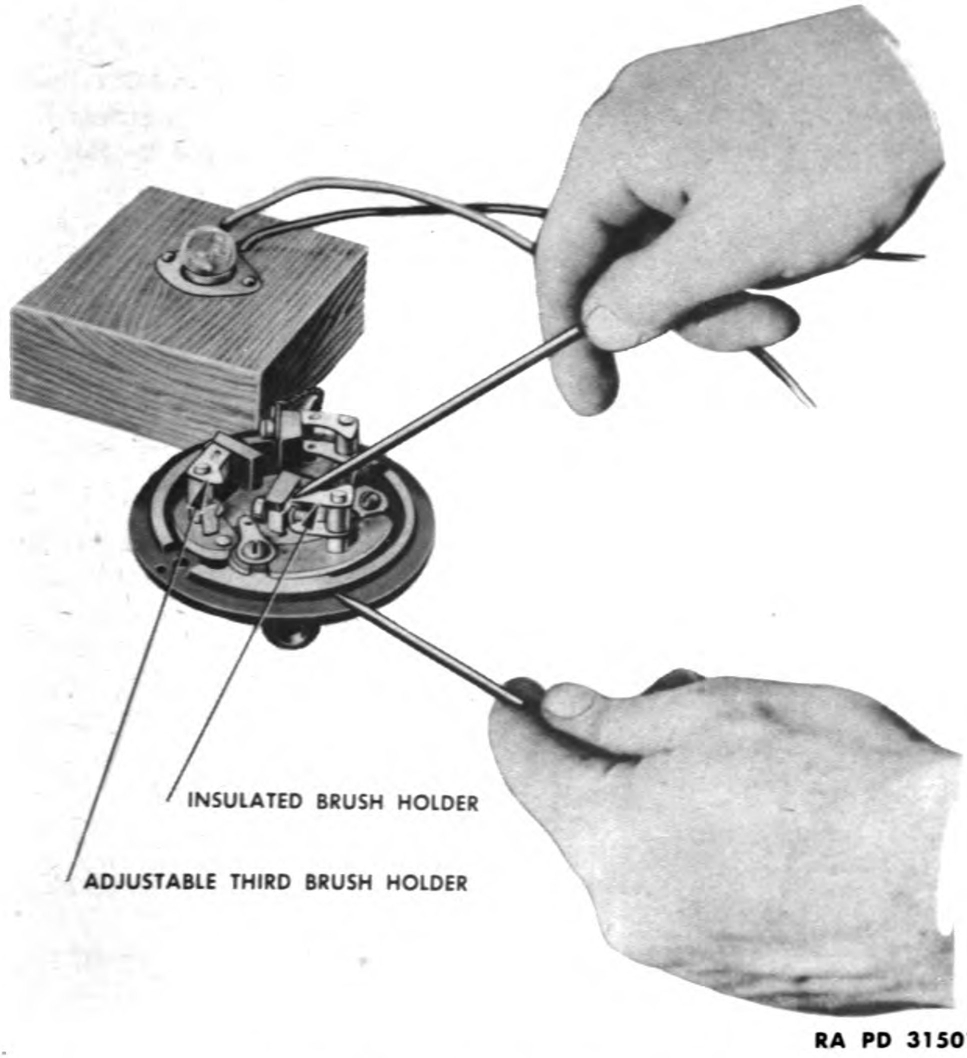


Figure 20—Testing Brush Holder for Grounds with Test Probes —Group 1 Generators

d. Drive End Head.

(1) Inspect head for cracks and inspect retainers for distortion. Discard defective parts. Discard bearing if it is worn or damaged. Discard felt washers if ragged or gritty.

(2) Install bearing in head. Replace head if bearing is loose and does not fit easily without binding.

(3) Pack bearing ½ full with high temperature grease and soak felts in engine oil (SAE 30). Drain off excess oil.

(4) Install bearing, retainers, washers, and screws, in head and tighten screws.

e. Miscellaneous Parts. Inspect all parts for wear, cracks, and distortion, and replace any part that cannot be straightened or cleaned up to give satisfactory service.

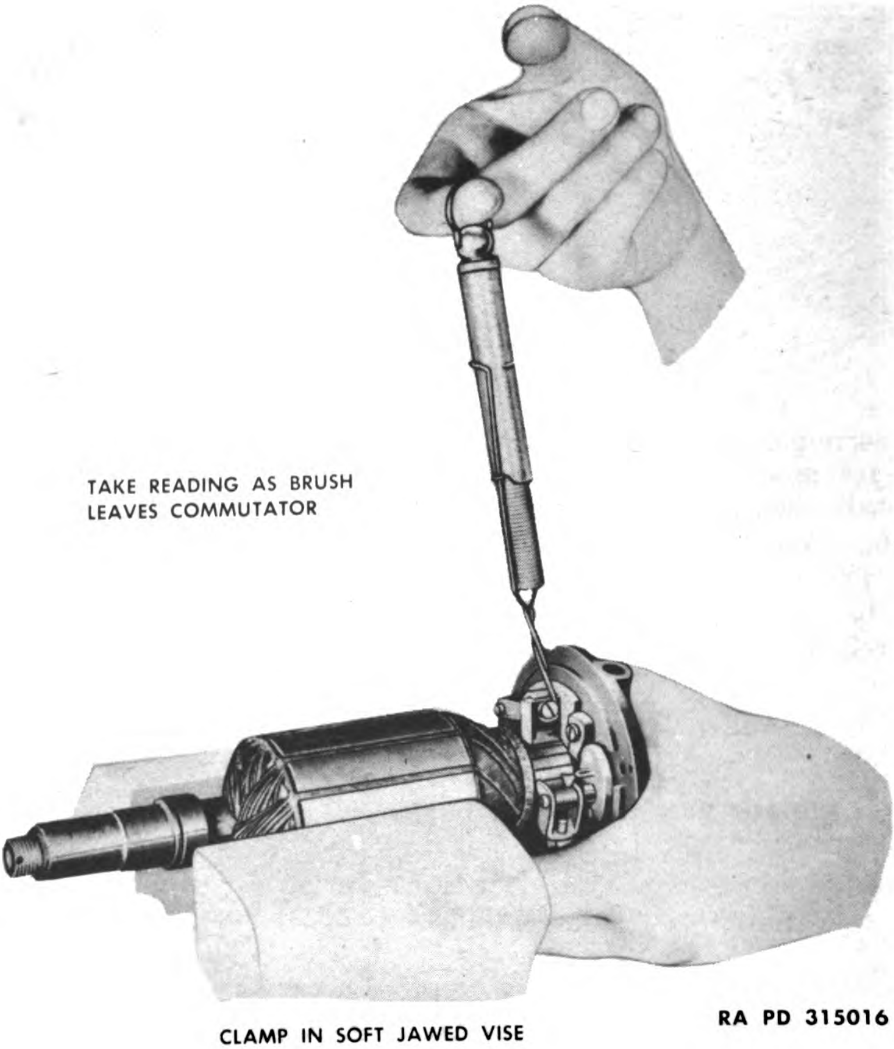


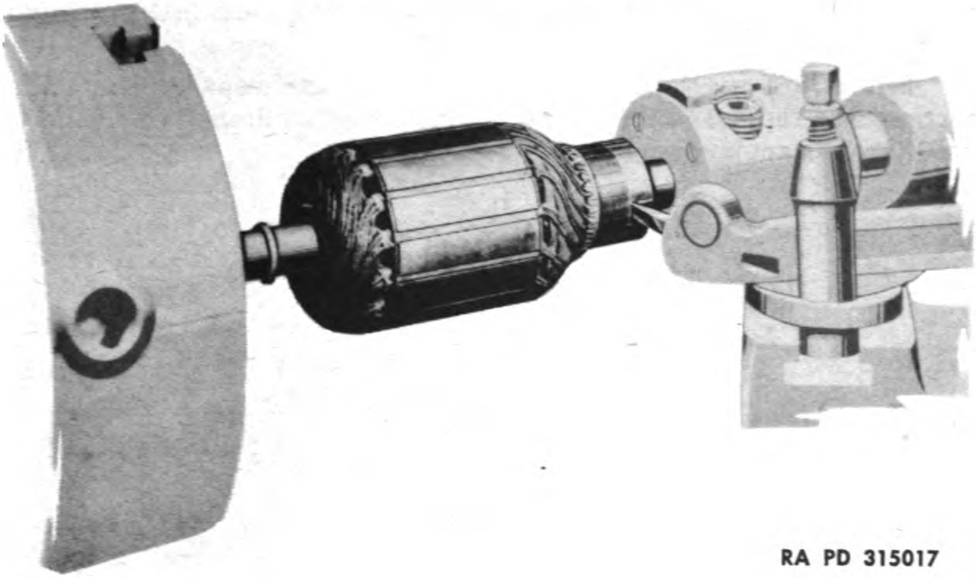
Figure 21—Measuring Brush Spring Tension on Group 1 Generator with Tension Gage (41-G-105)

10. REPAIR AND REBUILDING OF COMPONENTS.

a. Frame and Field Assembly.

(1) Replace defective leads, terminals, terminal studs, and insulation.

(2) If coils test grounded, open or shorted, remove pole shoe screw. Assemble new coil on pole shoe and install in frame. Dip pole-shoe



RA PD 315017

Figure 22—Turning Commutator Down

screw in boiled linseed oil and tighten securely. As screws are tightened hit frame a few sharp blows with a soft hammer to aline pole shoes. Install leads through hole in frame or solder leads to terminal stud.

b. Armature.

(1) Do not attempt to repair armatures with worn or bent shafts, badly scored core, shorted or open windings, or badly burned and scored commutator.

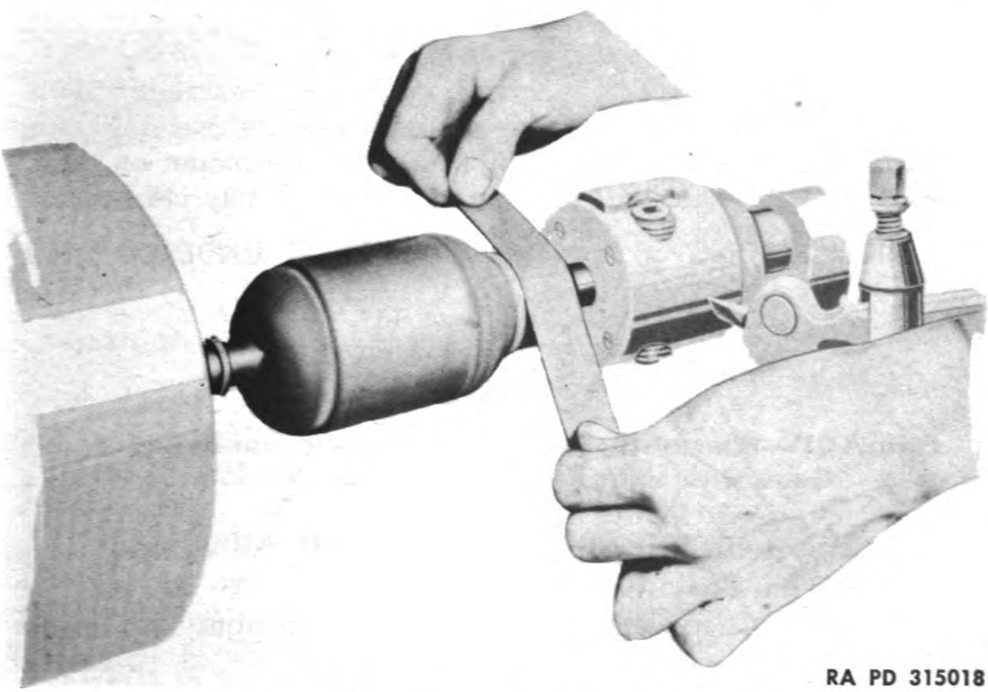


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Figure 23—Removing Commutator Burs with 2/0 Flintpaper

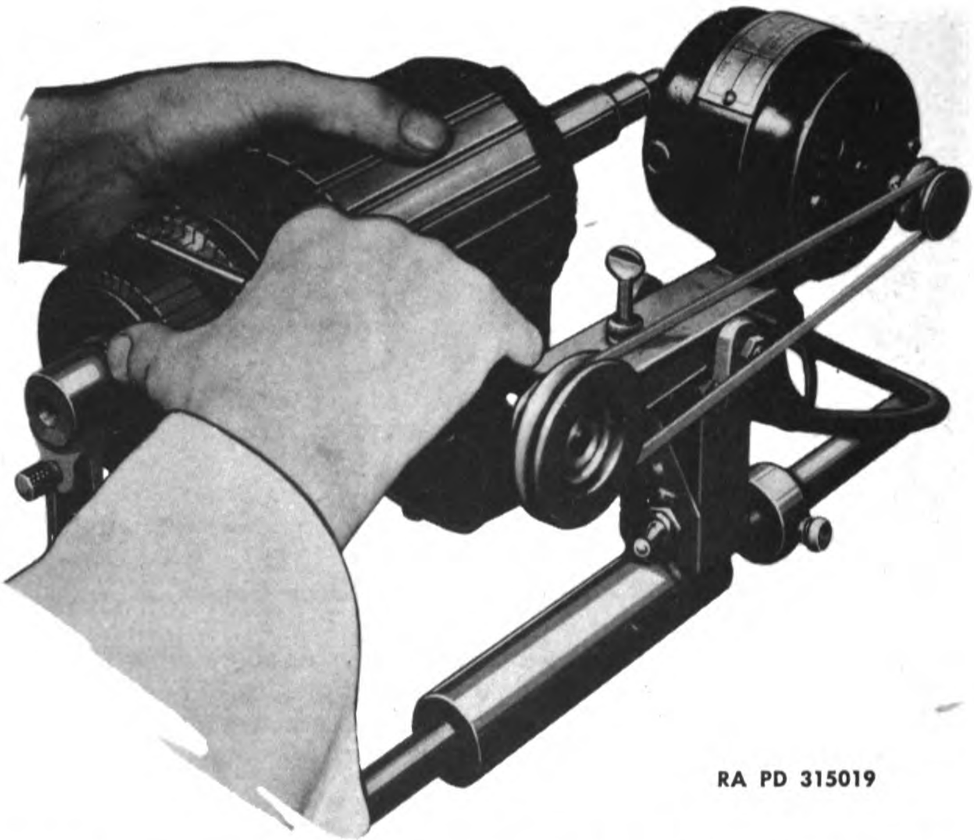


Figure 24—Undercutting Commutator Mica with Undercutter (41-U-300)

(2) If commutator is rough or worn or if run-out exceeds 0.0005 inch, place armature in lathe. Mount armature in lathe, preferably on shaft bearing seats if lathe is so equipped, otherwise mount on shaft centers. Take light cuts until commutator is completely cleaned up

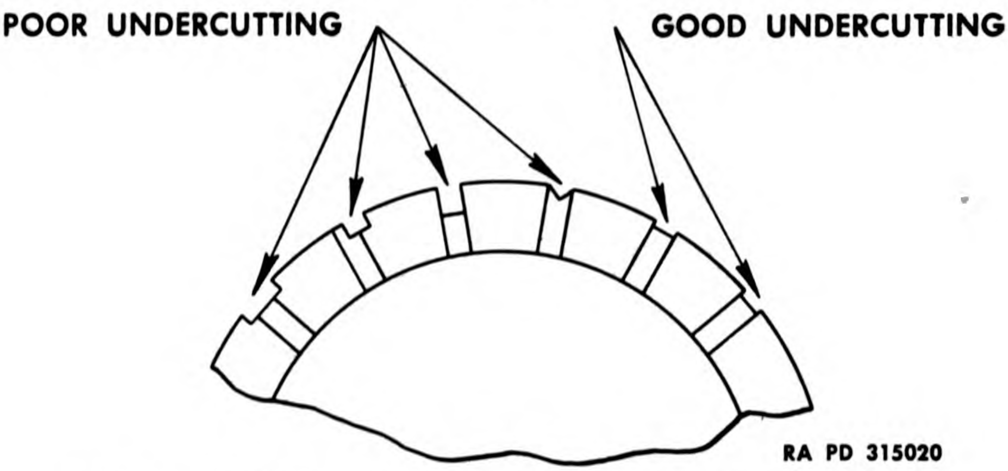


Figure 25—Examples of Good and Poor Undercutting

(fig. 22) then remove all burs with 2/0 flintpaper (fig. 23). Do not use armature if commutator is smaller than the diameter tabulated in paragraph 13 **b**. After turning commutator, undercut mica to a depth of 1/32 to 3/64 inch (figs. 24 and 25). Check armature for grounds and shorts (par. 9 **b** (2) and (4)).

c. Commutator End Head.

(1) Discard defective brush holders and plates.

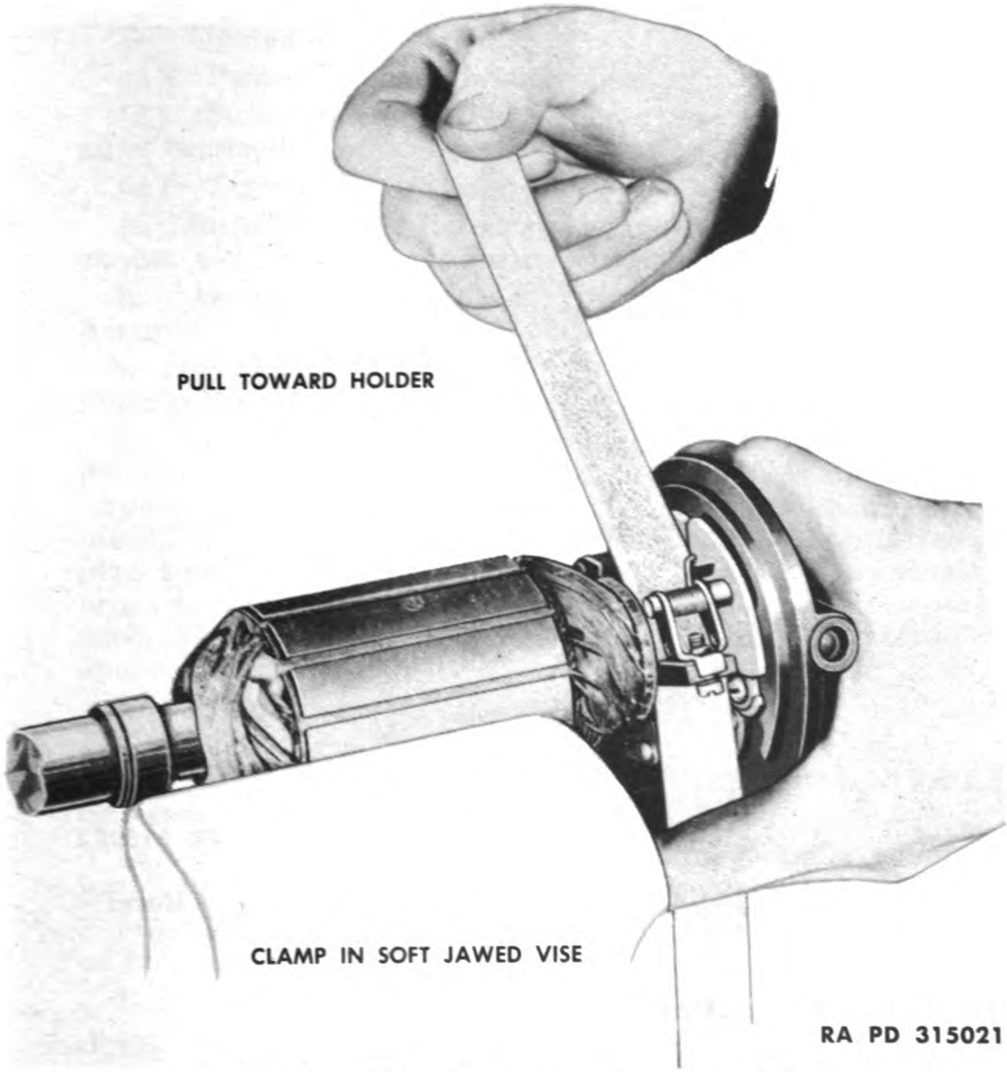


Figure 26—Seating New Generator Brushes with 2/0 Flintpaper

(2) To install new bronze bearing, drive old bearing out with arbor or bolt that rests on bearing but does not gouge bearing bore. Assemble new bearing on correct arbor, and press into place with arbor press. The arbor must have a diameter of the correct size to give bearing dimension tabulated in paragraph 13 **b**.

(3) If new brushes have been installed, mount armature in padded vise and install head, bearing and brushes, on armature. Cut a strip

of 2/0 flintpaper the exact width of commutator and place under a brush with sanded side toward brush. Hold flintpaper so that it fits commutator and pull so brush is forced toward holder (fig. 26). Once or twice is sufficient sanding to assure a perfect brush fit. Sand all three brushes.

d. **Drive End Head.** Replace defective parts (par. 9 d).

Figure 27—Pressing Armature Shaft into Drive End Head with Arbor Press

e. **Miscellaneous Parts.**

(1) Straighten cover band to fit closely against frame. Replace band if badly bent.

(2) Replace defective screws, washers, and miscellaneous parts.

11. ASSEMBLY.

a. **Assemble Drive End Head on Armature.** Press armature shaft into drive end head (fig. 27). Be sure shoulder on shaft is down tight against inner bearing race.

b. **Install Armature in Frame and Field.** Install armature in frame and field and turn drive end head so dowel pin enters hole.

c. **Install Commutator End Head.** Place commutator end head on generator and turn head until dowel pin enters hole in head. Hold heads in place.

d. **Install Through Bolts** (figs. 9 and 10). Install two through bolts and lock washers in generator. Make sure one bolt is under the field connection insulation. Start bolt with fingers but do not tighten.

e. **Install Commutator End Bearing** (ball bearing types only). Install cupped felt guard, felt washer, plain washer, and ball bearing, on commutator end of shaft (fig. 1). Press parts into head.

f. **Tighten Through Bolts.**

(1) Partially tighten through bolts.

(2) Strike generator frame once or twice with soft hammer to aline bearings.

(3) Tighten through bolts.

g. **Install Bearing Retainer** (ball bearing types only). Assemble washer and screw on end of shaft and tighten screw (fig. 10).

h. **Assemble Lock Nut on Shaft** (GAS 4172 and GDE 4108). Assemble nut on shaft and tighten with spanner wrench.

i. **Install Felt Protector and Spring Washer** (GDE 4107 only). Place protector on shaft and press spring washer into protector.

j. **Install Brushes.** Install brush screws and lock washers on brush holders. Place a brush on each screw with beveled face turned to seat on commutator. The thin brush must be assembled on the adjustable brush holder. Place terminal of field coil lead on third brush screw and place terminal of output lead on insulated main brush screw and tighten brush screws. Keep brushes alined on commutator as screws are tightened. Make sure ground lead is connected to grounded brush. Check above connections with internal wiring diagram (fig. 28).

k. **Install Distributor Drive Housing** (GDE 4107 and 4108 only) (fig. 9).

(1) Place gear on shaft. Insert gear pin and rivet both ends. Make sure gear and rivet are tight.

(2) Install distributor drive housing and gasket on generator and install and tighten three screws and lock washers.

(3) Install grease hole cover, end cap, pipe plug, and clamp screw, on housing.

l. **Install Pulley or Drive Gear.**

(1) Install Woodruff key on shaft and press into place.

(2) Place pulley or gear on shaft.

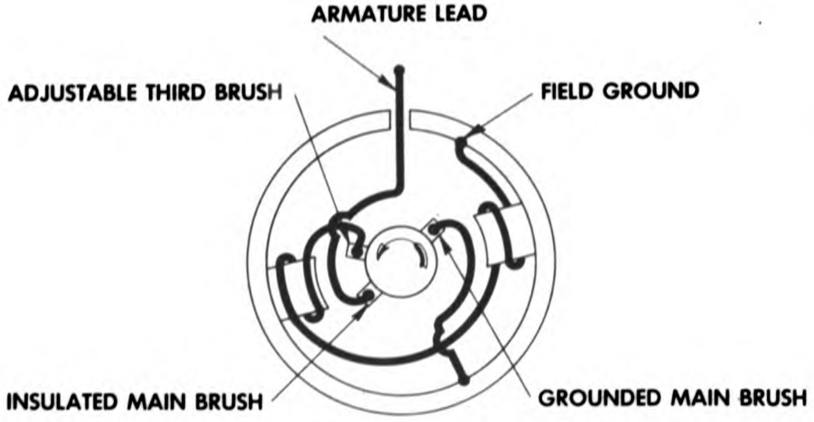
(3) Install and tighten shaft lock washer and nut.

m. **Install Commutator End Cover.** Install gasket, cover, and cover screws, and tighten (fig. 10).

12. TESTS AND ADJUSTMENTS.

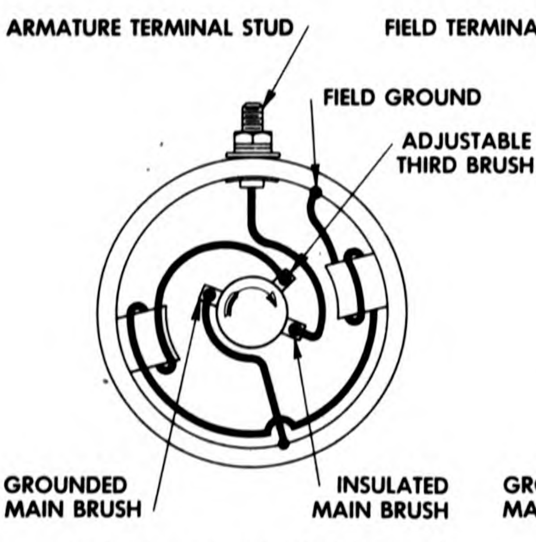
a. **Measure End Play.**

(1) Mount indicator (41-I-100) on generator frame or drive end



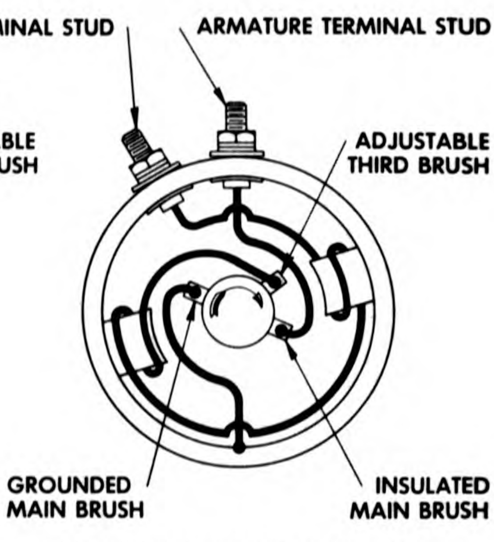
VIEWED FROM COMMUTATOR END

INTERNAL WIRING OF GAS-4151 GENERATOR



VIEWED FROM COMMUTATOR END

INTERNAL WIRING OF GAS-4166 AND GAS-4172 GENERATORS



VIEWED FROM COMMUTATOR END

INTERNAL WIRING OF GDE-4107 AND GDE-4108 GENERATORS

RA PD 315056

Figure 28—Internal Wiring Diagrams of Group 1 Generators

head with plunger in line with and against end of shaft. Move armature to its two extreme positions and read indicator (fig. 29). The end play must be 0.003 inches to 0.010 inches. If it is not within these limits it indicates improper generator assembly. Inspect drive end and commutator end bearings for looseness in heads and make sure drive end bearing is down against shoulder on shaft. Check distributor drive gear and drive end shaft lock nut for correct assembly.

b. Electrical Tests and Adjustments (par. 6 c).

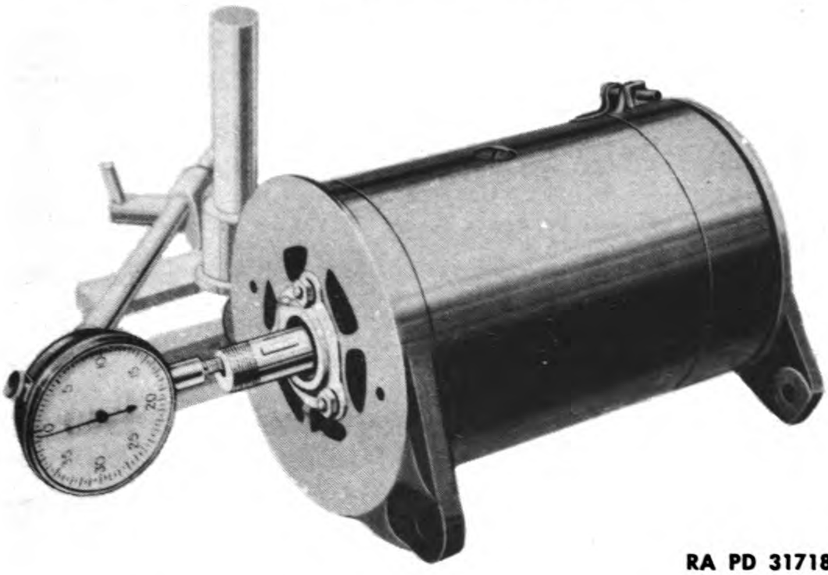


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Figure 29—Measuring Generator End Play with Indicator (41-I-100)

13. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Poles—2

Brushes—3

Lubrication—Three to five drops of engine oil (SAE 30) in oilers. Pack ball bearings ½ full with high temperature grease at assembly. Add ½ ounce of high temperature grease to distributor drive housing at overhaul. Soak felts and bronze bearings in engine oil (SAE 30) at assembly.

b. Mechanical.

Rotation—see tabulation (par. 13 d).

Brush length (new)—²¹⁄₃₂ inch.

Brush length (worn)—⅜ inch minimum.

Commutator diameter (new)—1.250 inches.

Commutator diameter (worn)—1.15 inches minimum. NOTE: *Can be used at smaller diameters if arcing at brushes is not excessive at full output.*

Brush spring tension (with new brushes)—15 to 20 ounces.
End play—0.003 inches to 0.010 inches.
Commutator run-out (total reading)—0.0005-inch maximum.
Commutator mica undercut—1/32 inch to 3/64 inch.
Shaft diameter (new)
  Commutator end
    GAS type—0.4715 to 0.4720 inch.
    GDE type—0.4723 to 0.4728 inch.
  Drive end—0.5897 to 0.5902 inch.
Bearing diameter (new)
  Commutator end
    GAS type—0.4720 to 0.4724 inch.
    GDE type†—0.4738 to 0.4748 inch.
  Drive end—0.5902 to 0.5906 inch.

c. Electrical.

Rated volts—6.
Ground polarity—(negative).
Control—GAS type—Third-brush control—uses cut-out relay only.
GDE type—Third-brush and two-charge regulator control.
Field fuse
  GAS type—none.
  GDE type—5 ampere fuse in regulator.
Field draw—complete set of coils—4.1 to 4.5 amperes at 6.0 volts.
Motorizing draw
  GAS type—5.3 to 5.9 amperes at 6.0 volts.
  GDE type—5.5 to 6.1 amperes at 6.0 volts.
Output setting
  GAS type—7.1 amperes at 8.0 volts (can be set up to 12.5* amperes at 8.0 volts.)
  GDE type—18.0* amperes at 8.0 volts.
Internal wiring—(fig. 28).
Test wiring—(fig. 7).

d. Tabulated Specifications.

Generator	Rotation
GAS 4151	Clockwise rotation at drive end.
GAS 4166	Counterclockwise rotation at drive end.
GAS 4172	Counterclockwise rotation at drive end.
GDE 4107	Counterclockwise rotation at drive end.
GDE 4108	Counterclockwise rotation at drive end.

*Do not set above these figures.
†This is the inside diameter of a new bearing after assembly in head.

CHAPTER 2

GENERATORS (Cont'd)

Section III

GENERATORS—GROUP 2

Paragraph

14. DESCRIPTION AND DATA.

a. Description.

(1) Group 2 generators are two pole, two-brush units with the output controlled by a separately mounted current and voltage regulator. Figures 30 and 31 are disassembled views of typical Group 2 generators showing the main components and their attaching parts.

(2) These generators have no internal regulation incorporated in their design and must be used with the regulator designed to operate with the generator. The data tabulation (par. 14 **b**) shows the original equipment regulator for use with each generator. Do not substitute. Some substitutions will operate satisfactorily for a short period but regulators will soon fail if used with incorrect generator.

(3) For model numbers of Group 2 generators, see paragraph 1.

b. Data.

Generator	Rated Volts	Rota-tion	Ground Polarity	Field Draw Volts	Field Draw Amperes	Motorizing Draw Volts	Motorizing Draw Amperes	Output* Volts	Output* Amperes	Max RPM	Regulator Used With
GDM 4803-1	12	CW	Pos	13.0	1.5 to 1.7	13.0	3.3 to 3.7	15.0	30.0	1500	VRX 4001A
GDM 4803-1N	12	CW	Neg	13.0	1.5 to 1.7	13.0	3.3 to 3.7	15.0	30.0	1500	VRX 4002A
GDM 5001-2	12	CW	Neg	13.0	1.5 to 1.7	13.0	3.3 to 3.7	15.0	35.0	1700	VRG 4103C
GDZ 4801	6	CW	Pos	6.0	1.6 to 1.8	6.0	4.1 to 4.6	8.0	30 to 37	1900	VRP 4001A
GDZ 4801A	6	CW	Pos	6.0	1.6 to 1.8	6.0	4.1 to 4.6	8.0	30 to 37	1900	VRP 4001A
GDZ 4801B	6	CW	Pos	6.0	1.6 to 1.8	6.0	4.1 to 4.6	8.0	30 to 37	1900	VRP 4001A
GDZ 4801C	6	CW	Pos	6.0	1.6 to 1.8	6.0	4.1 to 4.6	8.0	30 to 37	1900	VRP 4001A
GDZ 4801D	6	CW	Pos	6.0	1.6 to 1.8	6.0	4.1 to 4.6	8.0	30 to 37	1900	VRP 4001A
GEA 4802A-1	6	CW	Pos	6.0	1.6 to 1.8	6.0	4.4 to 4.9	8.0	35.0	1800	VRP 4002C
GEB 4810	6	CW	Pos	6.0	1.6 to 1.8	6.0	4.0 to 4.5	8.0	32.0	1250	VRP 4006E VRP 4004C
GEG 5001A	6	CW	Neg	6.0	1.6 to 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203A
GEG 5002	6	CW	Neg	6.0	1.6 to 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203B
GEG 5002A	6	CW	Neg	6.0	1.6 to 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203A
GEG 5002B	6	CW	Neg	6.0	1.6 tc 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203B
GEG 5002C	6	CW	Neg	6.0	1.6 to 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203A
GEG 5002D	6	CW	Neg	6.0	1.6 to 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203A
GEG 5002E	6	CW	Neg	6.0	1.6 to 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203A
GEG 5002F	6	CW	Neg	6.0	1.6 to 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203A
GEG 5004A	6	CW	Neg	6.0	1.6 to 1.8	6.0	4.7 to 5.2	8.0	40.0	1550	VRY 4203B
GEH 4806	12	CW	Pos	13.0	1.4 to 1.6	13.0	3.3 to 3.7	15.0	17.0	1225	VRS 4004B
GEH 5002-2	12	CCW	Pos	13.0	1.4 to 1.6	13.0	3.3 to 3.7	15.0	26.0	1500	VRG 4102B
GEH 5002-2N	12	CCW	Neg	13.0	1.4 to 1.6	13.0	3.3 to 3.7	15.0	26.0	1500	VRG 4103B
GEW 4802	6	CW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRY 4201A
GEW 4803	6	CW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRY 4202A
GEW 4803A	6	CW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRY 4202A
GEW 4804	6	CW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRP 4004G
GEW 4805	6	CCW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRY 4201A
GEW 4806	6	CW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRY 4201A
GEW 4806A	6	CW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRY 4201A
GEW 4806B	6	CW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRY 4201A
GEW 4806C	6	CW	Pos	6.0	1.6 to 1.8	6.0	3.2 to 3.6	8.0	25.0	1050	VRY 4201A
GFK 4801	12	CCW	Pos	13.0	1.5 to 1.7	13.0	3.3 to 3.7	15.0	30.0	1500	VAC 4001A
GFM 4801	12	CW	Neg	13.0	1.4 to 1.6	13.0	6.1 to 6.7	15.0	50.0	1900	VRH 4105A
GFM 4801A	12	CW	Neg	13.0	1.4 to 1.6	13.0	6.1 to 6.7	15.0	50.0	1900	VRH 4105A
GGA 4801A	12	CW	Neg	13.0	1.5 to 1.6	13.0	2.9 to 3.2	15.0	40.0	1600	VAM 4101A

CW—Clockwise rotation at drive end. CCW—Counterclockwise rotation at drive end. Neg—Negative ground. Pos—Positive ground.

*Do not operate at this output without ventilating fan and do not operate at higher outputs as it will overheat generator and may burn armature and fields.

GENERATORS—GROUP 2

15. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Remove terminal shield cover from shielded generators.

(2) Wipe outside of generator with cloth dampened in dry-cleaning solvent. Make sure terminals and pulley or gear are clean. Do not allow dry-cleaning solvent to enter generator.

b. Inspection.

(1) Inspect frame, end heads, and fan, for wear and cracks. If any part is cracked disassemble generator and discard cracked part (pars. 16 to 22). If drive pulley is cracked or broken, or if belt surface is rough, remove and discard pulley (par. 16). If any fan blade is broken or cracked, remove and discard fan. Generator drive gears, if used, must be in good condition with no teeth missing or damaged. Gears will operate satisfactorily with some wear but must be replaced if wear is uneven or excessive.

(2) Take out clamp screw and lift cover band from generator.

(3) Inspect brushes and brush holders. Lift brush arm with hook (fig. 32) and pull brushes from holders. Install new brushes if brushes are oil soaked or are worn to less than ½ inch long. To install new brushes disconnect brush lead from holder (fig. 33). Install new brush in holder with beveled face turned to fit commutator and connect lead to holder. Connect field coil or terminal stud lead at same time. If brush holders or arms are dirty, gummy, or corroded, or if brushes do not slide freely, overhaul generator (pars. 16 to 22). Inspect alinement of brushes on commutator. If edges of brushes are not in perfect alinement with commutator segments disassemble generator and install new commutator end head.

(4) If commutator is rough or worn disassemble generator and turn down commutator (par. 19 **b**). If commutator is only dirty, clean by holding 2/0 flintpaper against it while turning armature slowly. Blow sand out of generator with clean dry compressed air.

(5) If new brushes have been installed cut strip of 2/0 flintpaper the exact width of commutator. Lift brush slightly and slide flintpaper under brush with sanded side toward brush. Hold flintpaper tightly against commutator without rounding edges of brush and pull so that brush is forced toward brush holder (fig. 34). Once or twice is sufficient as additional sanding merely shortens brush life. Repeat sanding on all brushes.

c. Testing.

(1) Group 2 generators are tested by two different hookups depending on internal connections of generator. The following lists separate Group 2 generators into two types:

Group 2A

GDM 4803-1	GDZ 4801A	GDZ 4801D	GEH 4806
GDM 4803-1N	GDZ 4801B	GEA-4802A-1	GEW 4804
GDZ 4801	GDZ 4801C	GEB 4810	

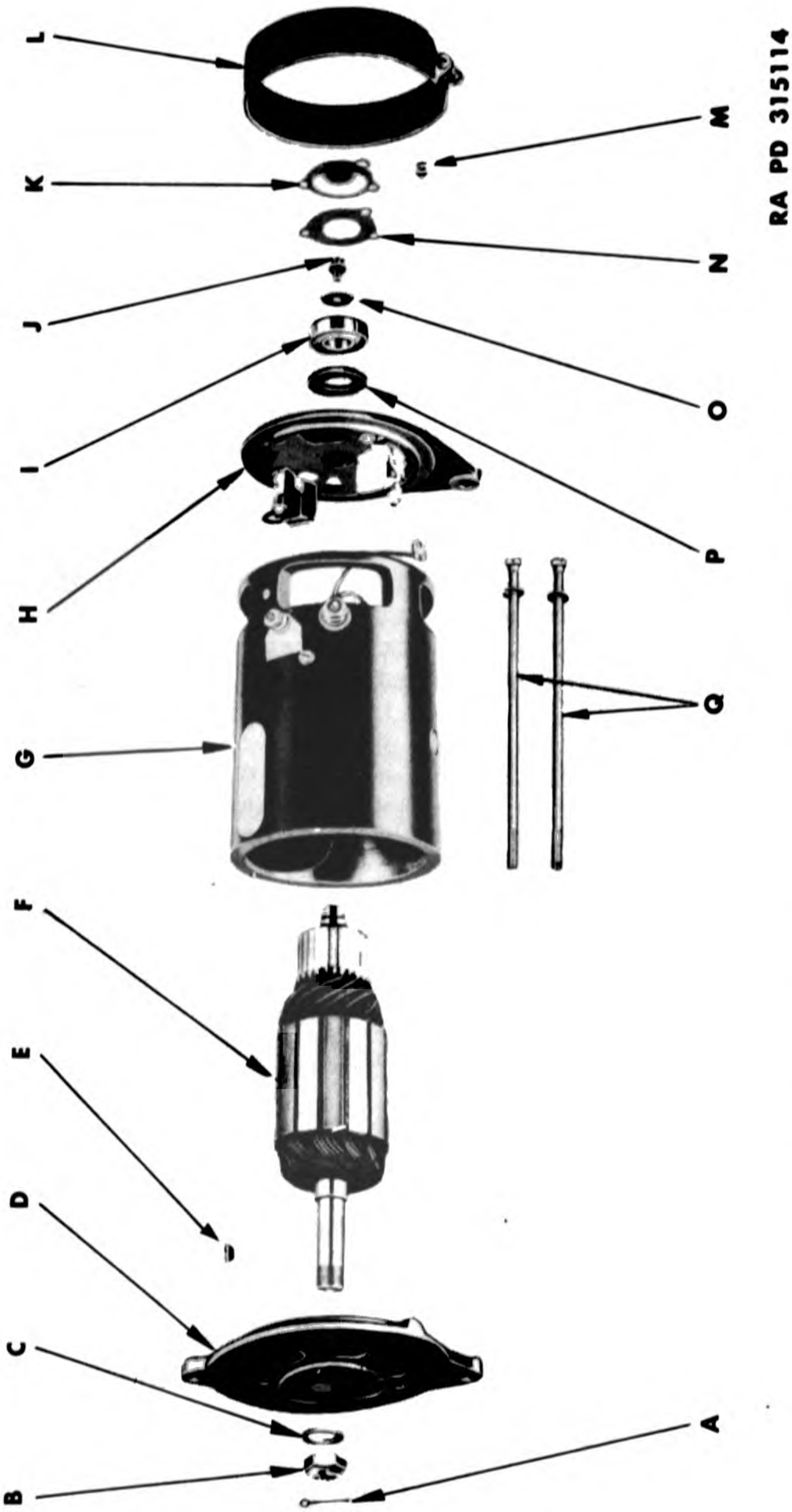


Figure 30—Main Components of Group 2 Generators

A—COTTER PIN	J—SHAFT SCREW AND LOCK WASHER
B—SHAFT NUT	K—COMMUTATOR END COVER
C—LOCK WASHER	L—COVER BAND
D—DRIVE END HEAD ASSEMBLY	M—COVER SCREW
E—WOODRUFF KEY	N—COVER GASKET
F—ARMATURE	O—BEARING RETAINING WASHER
G—FRAME AND FIELD ASSEMBLY	P—FELT WASHER
H—COMMUTATOR END HEAD ASSEMBLY	Q—THROUGH BOLTS
I—BALL BEARING	

RA PD 315114B

Legend for Figure 30—Main Components of Group 2 Generators

Group 2B

GDM 5001-2	GEG 5002D	GEW 4802	GEW 4806B
GEG 5001A	GEG 5002E	GEW 4803	GEW 4806C
GEG 5002	GEG 5002F	GEW 4803A	GFK 4801
GEG 5002A	GEG 5004A	GEW 4805	GFM 4801
GEG 5002B	GEH 5002-2	GEW 4806	GFM 4801A
GEG 5002C	GEH 5002-2N	GEW 4806A	GGA 4801A

(2) MEASURE FIELD COIL DRAW.

(a) Mount generator on test stand.

(b) Use fully charged battery of same rated voltage as generator. Connect one test stand battery lead and one voltmeter lead to generator field terminal. On Group 2A generators connect other battery and voltmeter leads to generator armature terminal (fig. 35). On Group 2B generators connect second battery lead and voltmeter lead to generator frame (fig. 36).

(c) Close test stand battery switch and adjust rheostat until voltmeter reading is the figure specified for generator being tested. Current must be within limits specified (par. 14 **b**). Any other reading indicates shorted, open-circuited or grounded field coils, and generator must be disassembled and overhauled (pars. 16 to 22).

(d) Open test stand battery switch.

(e) Disconnect leads from generator.

(3) MEASURE MOTORIZING DRAW.

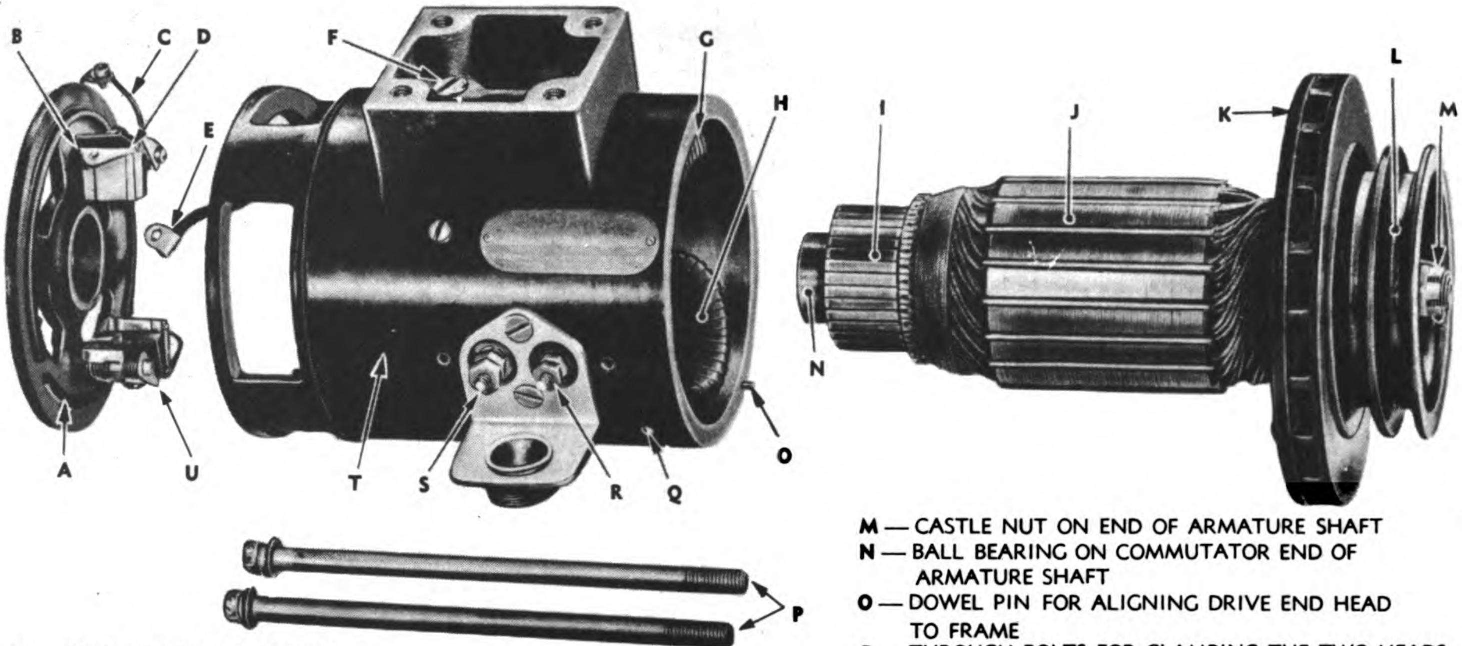
(a) Connect battery to test stand for voltage and polarity listed in tabulation (par. 14 **b**).

(b) Connect battery ground lead to generator frame and connect second battery lead to generator armature terminal.

(c) Connect voltmeter from generator frame to generator armature terminal.

(d) On Group 2A generators run jumper lead from field terminal to generator frame (fig. 35). On Group 2B generators connect jumper lead to field and armature terminals (fig. 36).

(e) Close test stand battery switch. Generator must operate as a motor with armature turning slowly.



A — COMMUTATOR END HEAD
B — JUNCTION POINT FOR INSULATED BRUSH LEAD AND GENERATOR OUTPUT LEAD
C — INSULATED BRUSH LEAD
D — INSULATED BRUSH HOLDER
E — GENERATOR OUTPUT LEAD TERMINAL
F — FIELD POLE SHOE SCREW
G — TOP FIELD COIL
H — LOWER FIELD COIL
I — ARMATURE COMMUTATOR
J — ARMATURE CORE
K — DRIVE END HEAD
L — DRIVE PULLEY
M — CASTLE NUT ON END OF ARMATURE SHAFT
N — BALL BEARING ON COMMUTATOR END OF ARMATURE SHAFT
O — DOWEL PIN FOR ALIGNING DRIVE END HEAD TO FRAME
P — THROUGH BOLTS FOR CLAMPING THE TWO HEADS TO THE FRAME
Q — LOWER FIELD COIL TERMINAL GROUND SCREW
R — GENERATOR INSULATED FIELD TERMINAL POST
S — GENERATOR ARMATURE OUTPUT TERMINAL POST
T — GENERATOR FIELD FRAME
U — GROUND BRUSH HOLDER AND BRUSH

RA PD 16918

Figure 31—Main Components of GFM 4801 Generator

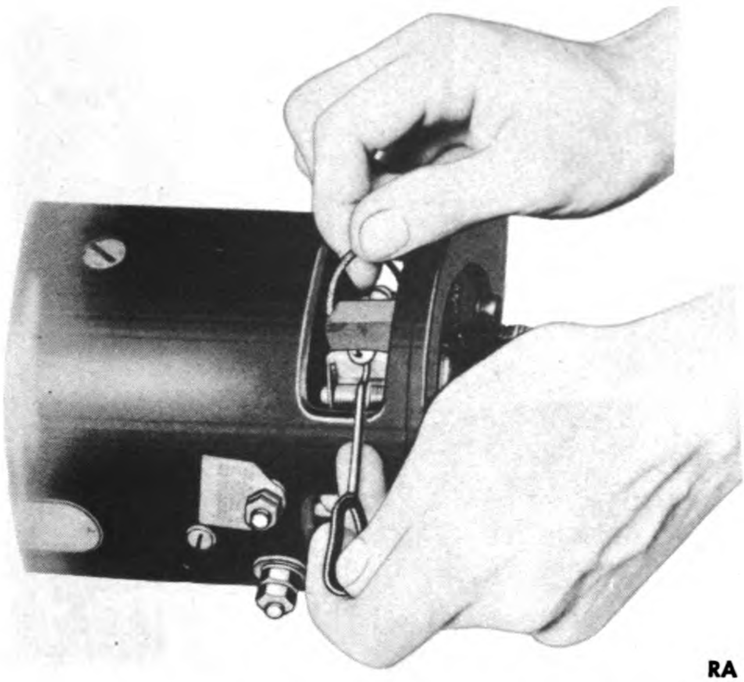
(f) Adjust voltage to specified value (par. 14 **b**) and read ammeter. If current is not within specifications or if armature does not turn, it indicates worn bearings, incorrect bearing alinement, shorts, or improper generator assembly. Overhaul generator if motoring current is not within limits (pars. 16 to 22).

(g) Open test stand battery switch.

(4) CHECK GENERATOR OUTPUT (figs. 35 and 36).

(a) With generator connected as above for motorizing test connect armature shaft to test stand motor with coupling.

(b) Close test stand battery switch.



RA PD 315023

Figure 32—Removing Generator Brush from Holder

(c) Start test stand motor so that generator is driven in direction specified (par. 14 **b**).

(d) Increase speed slowly keeping voltage at figure specified (par. 14 **b**) by adjusting load rheostat across battery. It is important that voltage be held at figure specified. Note ammeter reading as speed is increased. Current output will increase as speed is increased. When output reaches figure specified for generator being tested (par. 14 **b**) read tachometer. Generator speed must not be above maximum noted.

(e) If new brushes have been installed they will affect readings obtained in output test. New brushes should be run in to make sure of a perfect fit on commutator. To run in new brushes operate at near maximum output for 15 to 30 minutes (par. 15 **c** (4) *(d)* above). Stop generator and open test stand battery switch. Remove brushes from their holders and inspect contact surface. If surface is not shiny

over its entire area, install brush and operate generator again at near maximum output until upon inspection brush shows perfect fit.

(f) Allow generator to cool to room temperature then check output (par. 15 c (4) *(d)* above). If it is necessary to check generator while

RA PD 315024

Figure 33—Disconnecting Brush Lead from Holder

hot, speed will be from 50 to 200 revolutions per minute higher than figure specified (par. 14 **b**).

(g) If specified output cannot be obtained or if speed is above maximum given it indicates high resistance connections, poor brush contact, dirty commutator, worn or oil soaked brushes, faulty armature, or improper brush and commutator end head assembly. Disassemble and overhaul generator (pars. 16 to 22) if output figures are not within specifications.

(5) LUBRICATION. If generator tests satisfactorily, add three to five drops engine oil (SAE 30) to each oiler on generators that do not use seal bearings. Install cover band on generator and cover all inspection holes. Install and tighten clamp screw.

16. DISASSEMBLY.

a. Remove Cover Band. Take out clamp screw and pull band from generator.

b. Disconnect Brush Leads. Take out brush lead screw (fig. 33).

c. Remove Brushes. Lift brush arm with hook and pull brushes from holders (fig. 32).

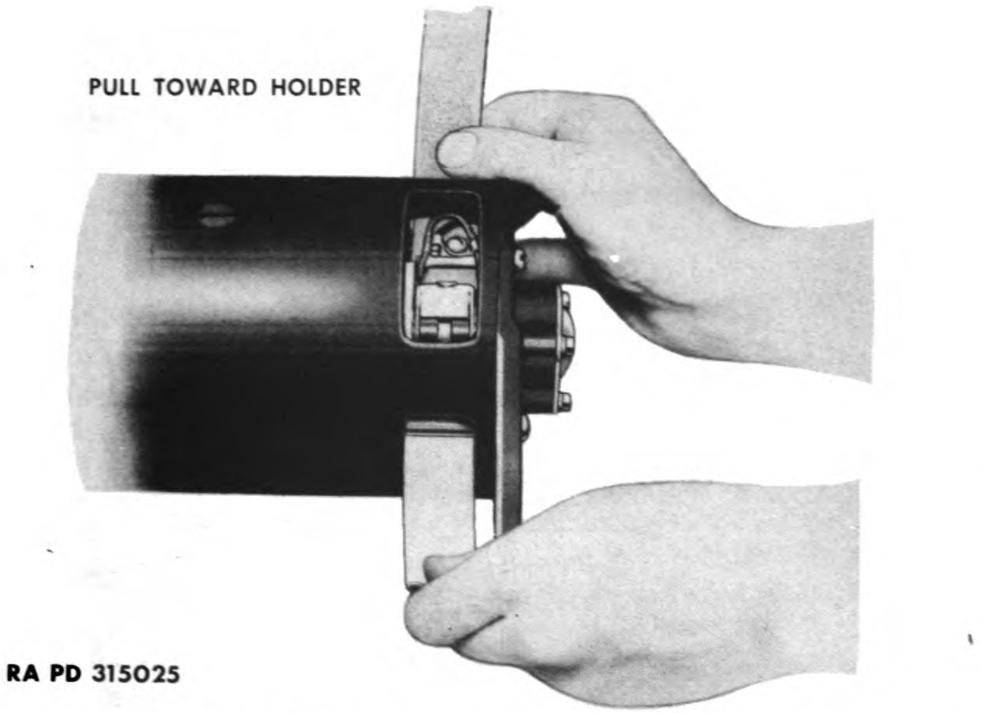


Figure 34—Seating New Generator Brushes with 2/0 Flintpaper

d. Remove Commutator End Ventilating Fan (if pertinent) (fig. 37).

(1) Hold armature so that it does not turn and remove shaft nut.

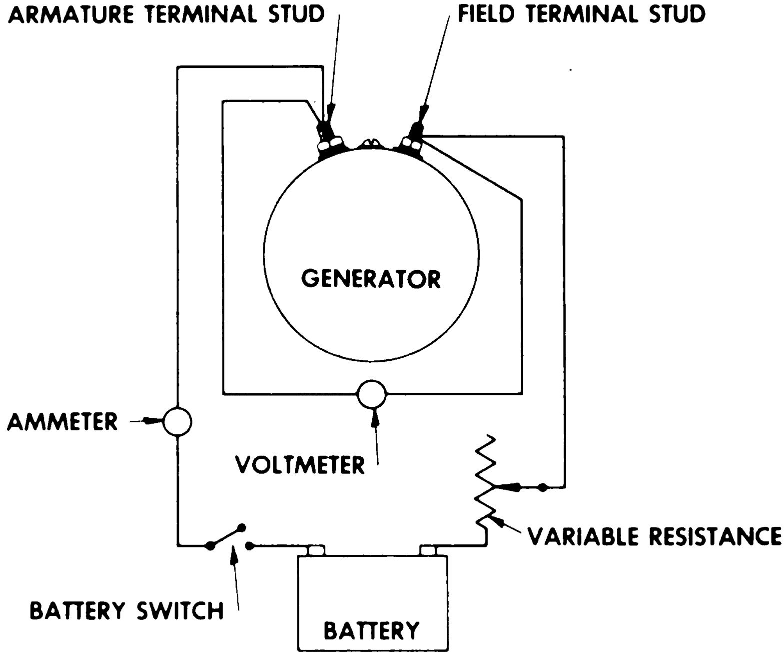
(2) Remove lock washer and fan from shaft.

(3) Remove Woodruff key from shaft.

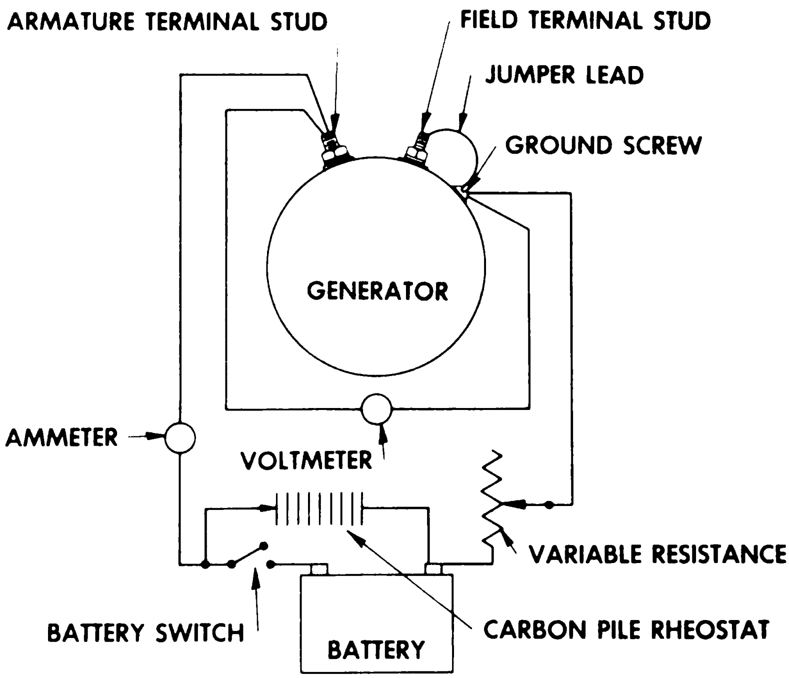
e. Remove Commutator End Cover (figs. 37, 38, and 39). Take out cover attaching screws and lift off cover and gasket.

f. Remove Air Deflector (if pertinent). Take out screws and lift off deflector (fig. 37).

g. Remove Bearing Screw or Nut (commutator end ball bearing types). Take bearing retaining screw out of shaft (fig. 38). Lift off washer, felt washer, and felt retainer, if present.



FIELD COIL DRAW TEST HOOKUP



MOTORIZING DRAW AND OUTPUT TEST HOOKUP

RA PD 315054

Figure 35—Test Hookups for Group 2A Generators

h. Remove Frame Screws or Nuts (figs. 37, 38, and 39).

(1) If nuts are used on commutator end of frame screws take off these two nuts.

(2) If fillister head frame screws are used take out two screws.

i. Remove Commutator End Head. Pull head from generator. It may be necessary to tap lightly with soft hammer to loosen head.

j. Remove Ball Bearing from Commutator End.

(1) Press bearing, felt washers and retainers out of head with fingers. Do not remove bronze bearings.

(2) On GFM generators, bearing may remain on armature shaft. Pull bearing from shaft.

k. Remove Armature and Drive End Head. Tap drive end head lightly with soft hammer and pull head and armature from frame.

l. Remove Drive Pulley or Gear.

(1) Clamp armature in padded vise.

(2) Remove cotter pin, if used, from shaft.

(3) Take off shaft nut, lock washer, and plain washer.

(4) Pull gear or pulley from shaft.

(5) Remove Woodruff key.

(6) Slide oil thrower, if used, off shaft.

m. Remove Armature from Drive End Head (fig. 11).

(1) Mount assembly on arbor press and press against drive end of armature shaft. Hold armature in one hand so that it will not fall and become damaged.

(2) On GEH 4806 the shaft sleeve and spacer will come off with drive end head.

(3) Remove felt protector, if used, from shaft.

17. CLEANING OF COMPONENTS.

a. Frame and Field Assembly. Thoroughly clean frame and field assembly with cloth dampened in dry-cleaning solvent. Do not soak in dry-cleaning solvent and be careful not to damage insulation or leads. Blow dry with clean dry compressed air.

b. Armature. Blow all loose dirt off with compressed air. Wipe armature with clean cloth dampened in non oily dry-cleaning solvent. Clean commutator with 2/0 flintpaper. Clean dirt from between commutator bars but do not damage or form burs on bars or mica. Keep commutator clean and do not handle.

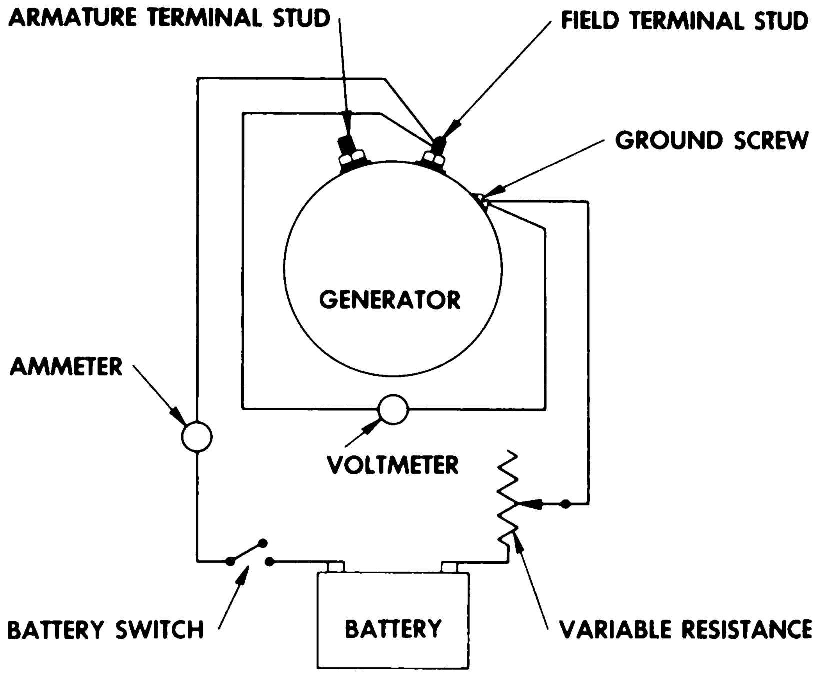
c. Commutator End Head.

(1) Soak head and brush holders in dry-cleaning solvent and clean with soft rag. Blow dry with compressed air. Remove all lint.

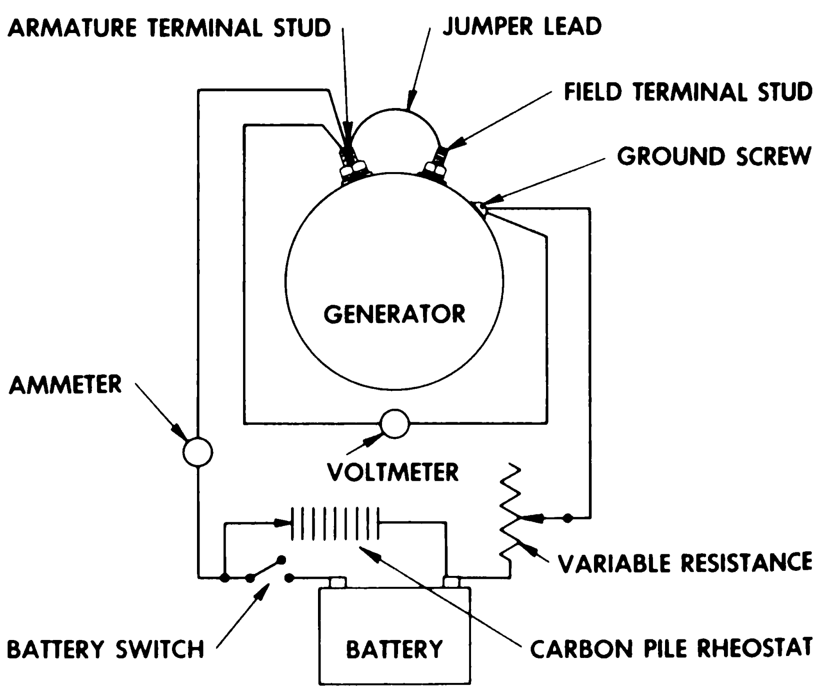
(2) Wipe brushes with clean dry rag.

(3) Soak plain and semi-shielded ball bearings in dry-cleaning solvent and clean thoroughly. Blow dry with clean compressed air but do not spin.

(4) Wipe fully shielded and sealed ball bearings clean with lint-



FIELD COIL DRAW TEST HOOKUP



MOTORIZING DRAW AND OUTPUT TEST HOOKUP

RA PD 315055

Figure 36—Test Hookups for Groups 2B, 3 and 4 Generators

less cloth dampened in dry-cleaning solvent. Do not dip in dry-cleaning solvent as these bearings cannot be repacked with grease.

(5) Wipe felt washers and wicks clean with rag.

(6) Soak retainers, covers, gaskets and other metal parts in dry-cleaning solvent and clean and dry thoroughly.

d. Drive End Head.

(1) Take out bearing retainer screws and remove retainers, felt washers, and bearing.

(2) Soak head in dry-cleaning solvent and clean with soft rag. Blow dry with compressed air and remove all lint.

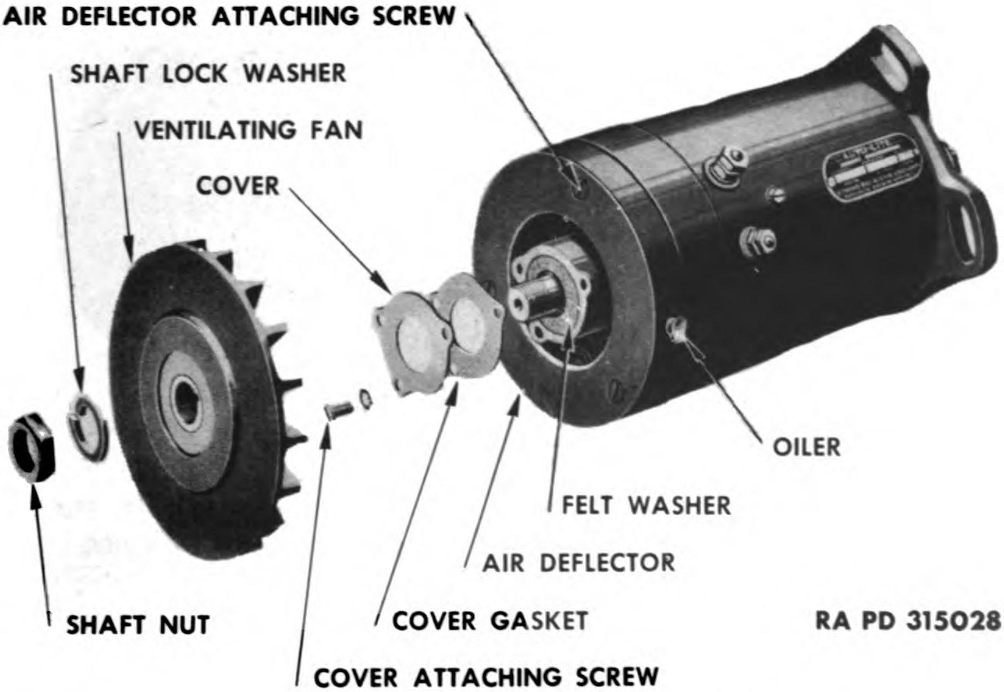


Figure 37—Commutator End Construction of Group 2 Generators with Fan on Commutator End

(3) Soak plain and semi-shielded ball bearings in dry-cleaning solvent and clean thoroughly. Blow dry with compressed air but do not spin.

(4) Wipe fully shielded and sealed ball bearings clean with lint-less cloth dampened in dry-cleaning solvent. Do not dip in dry-cleaning solvent as these bearings cannot be repacked with grease.

(5) Wipe felt washers and wicks clean with rag.

(6) Soak retainers, gaskets, screws and nuts, in dry-cleaning solvent and clean and dry thoroughly.

e. Miscellaneous Parts. Clean balance of generator parts in dry-cleaning solvent and dry thoroughly.

18. INSPECTION AND TEST OF COMPONENTS.

a. Frame and Field Assembly.

(1) Inspect frame and field for worn or frayed insulation, broken leads, and loose or corroded terminals. If any of these conditions are found, repair or replace faulty parts (par. 19 **a**).

(2) Check field coils for grounds with test probes consisting of lamp in series with two points and a source of electricity (fig. 12). Make sure no leads are touching frame. On Group 2B (par. 15 **c**) generators remove field ground screw and bend ground lead away from frame. Touch one test probe to field terminal stud and touch other probe to an unpainted ground on frame (fig. 40). If lamp lights

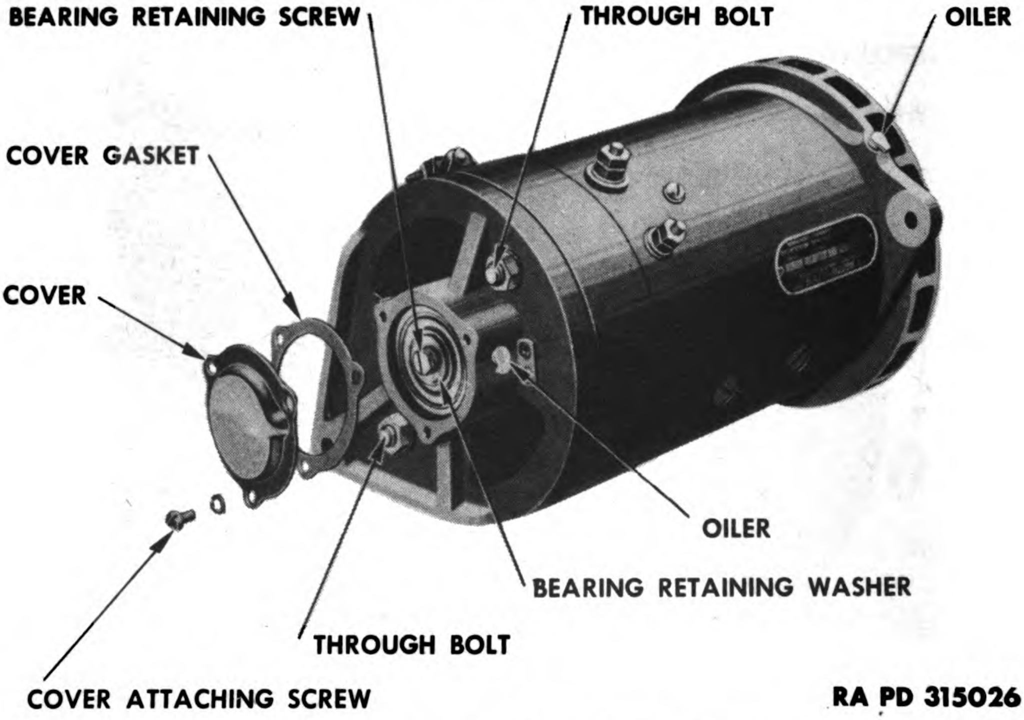


Figure 38—Commutator End Construction of Group 2 Generators with Ball Bearing at Commutator End

it indicates a ground is present. To check further remove nuts and washers from field terminal stud and press stud out of frame. On Group 2A generators also remove armature terminal stud from frame. Repeat ground test. If coils are not grounded in second test it indicates faulty terminal post insulation which must be replaced. If coils still test grounded, unsolder connection between the two coils and check each coil separately. Replace grounded coil (par. 19 **a**).

(3) Touch test probes to field terminal stud and to armature terminal stud on Group 2A (fig. 41) or to field terminal stud and field ground terminal on Group 2B (fig. 42). If lamp does not light it indicates an open circuit is present. Check each coil by touching test probes to connection between coils and to each end of coil assembly. Install new coil if either coil tests an open circuit (par. 19 **a**).

(4) Make sure leads are not touching frame and touch test probes to ground on frame and to armature terminal stud. If lamp lights, ground is present in the armature terminal stud. Remove stud from frame and install new insulation. Touch probes to armature terminal stud and brush lead terminal. If lamp does not light, lead is open and must be repaired or replaced (par. 19 **a**).

(5) Measure field coil draw of two coils in series. Connect an ammeter, battery, and variable resistance, in series with two field coil leads or terminals. Connect voltmeter to two field coil terminals. Adjust voltage to figure specified and read ammeter (par. 22 **c**). If current is not within limits specified it indicates short within a coil. To check which coil is shorted connect battery, ammeter and voltmeter, across each coil separately. Adjust voltage to specified figure (par. 22 **c**). Current must be twice current specified for two coils in series. If either coil is shorted, install new coil (par. 19 **a**).

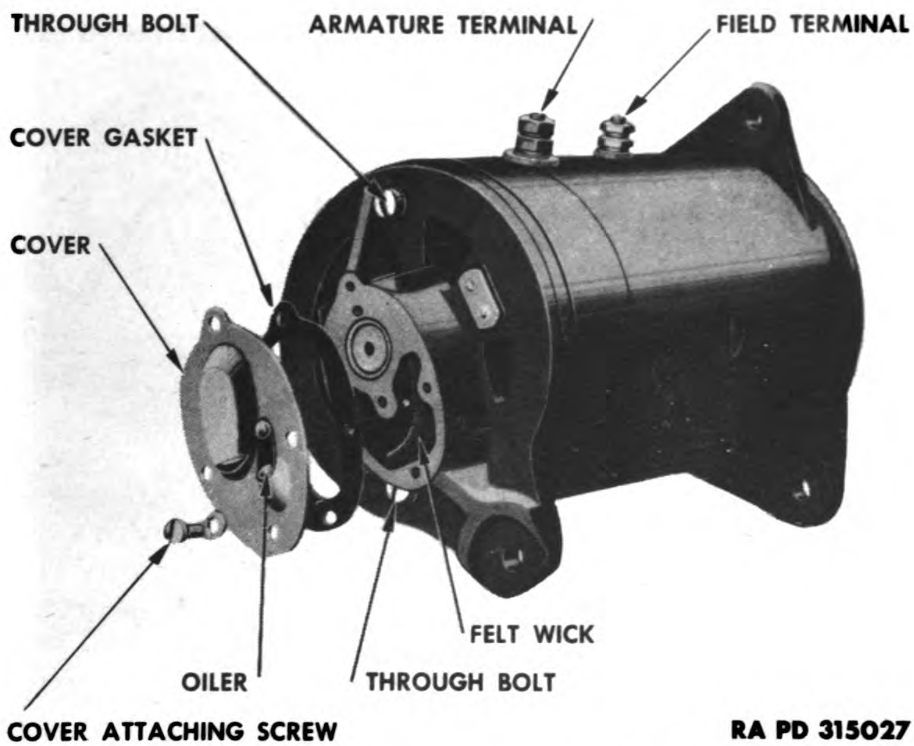


Figure 39—Commutator End Construction of Group 2 Generators with Bronze Bearing at Commutator End

b. Armature.

(1) Inspect armature to make sure all coils are properly pressed into core slots and all are soldered to commutator risers. Replace armature if windings are loose or unsoldered at commutator. Inspect core for wear and discard armature if scored badly. If commutator is rough or worn, turn down (par. 19 **b**). Inspect shaft bearing seats for wear and discard armature if wear is evident.

(2) Place armature on "V" block and touch one test probe to shaft or core. Touch the other probe to each commutator segment in turn (fig. 17). If a ground is present lamp will light. Do not touch probes to bearing or brush surface as an arc would mar smooth finish. Discard armature if grounded.

(3) Touch test probes to each pair of adjacent commutator bars (fig. 43). If lamp does not light it indicates an open circuit and armature must be replaced. Repeat this test on every pair of adjacent bars. Do not touch brush surface.

(4) Place armature on growler and hold thin steel strip on core (fig. 18). Rotate armature slowly through a complete revolution. If

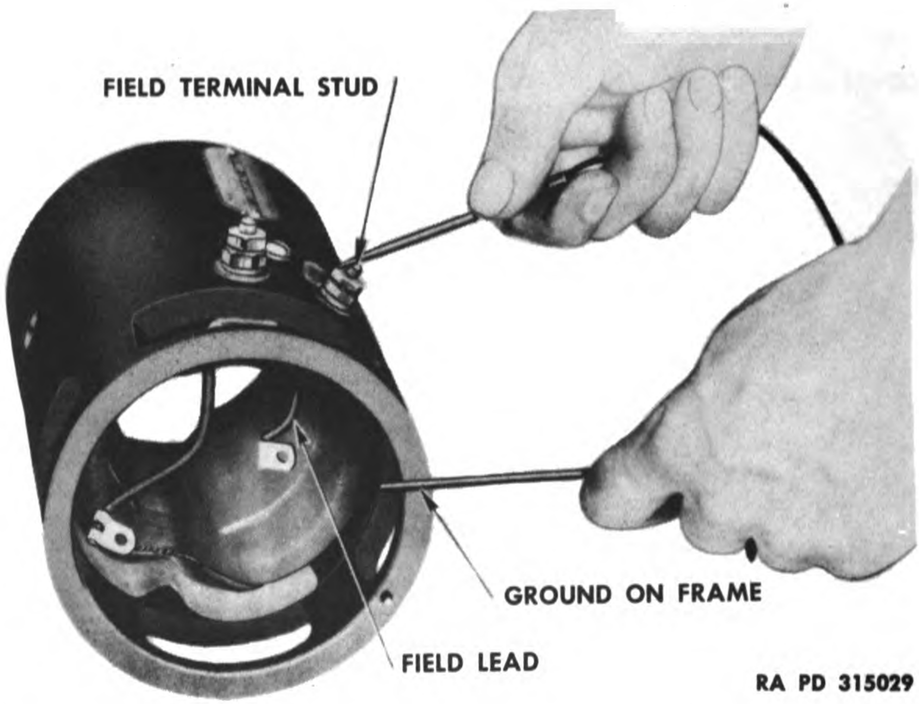


Figure 40—Testing Field Coils for Grounds with Test Probes—Group 2 Generators

short circuit is present steel strip will become magnetized and vibrate. Discard shorted armature.

(5) Place armature with bearing seats on "V" blocks and place dial indicator with plunger against commutator (fig. 19). Rotate armature and measure total commutator runout. If total reading is larger than 0.0005 inch turn down commutator (par. 19 **b**).

c. Commutator End Head.

(1) Inspect head and parts for cracks and distortion and discard if these conditions are found. Discard felt washers and wicks if they are torn or gritty. Discard gasket if not in perfect condition. Install new brushes if they are cracked, oil soaked, worn to less than ½ inch long or if brush leads are frayed, broken, or corroded.

(2) With test probes check insulated brush holder for grounds (fig. 44). If ground is present discard head.

(3) Place armature in padded vise and install commutator end head on shaft. On ball bearing types install bearing and washers in head. Feel side play in bearing. If any side movement can be felt it indicates worn bearing, worn shaft, or loose bearing fit in head. Inspect to find cause of side play and replace parts affected.

(4) Inspect shielded and sealed bearings and discard if they are improperly lubricated and if they do not turn freely without binding or grating.

(5) With head installed on armature, install brushes in holders. Make sure beveled face is turned to fit commutator. Discard head if

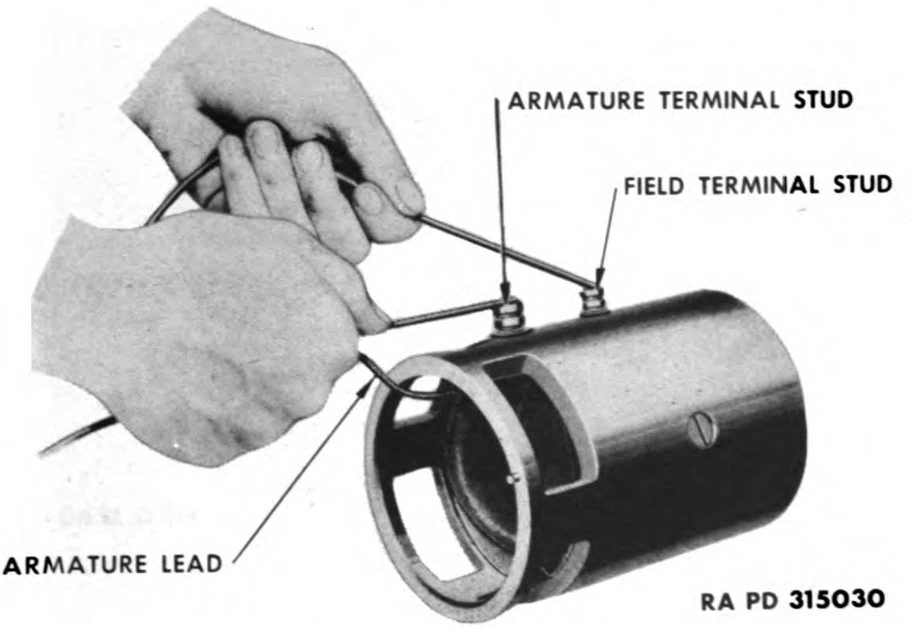


Figure 41—Testing Field Coils for Open Circuit with Test Probes—Group 2A Generators

brushes do not slide freely or if edges of brushes are not in perfect alinement with commutator segments.

(6) Hook tension gage in hole in end of brush arm and pull on a line parallel to face of brush (fig. 45). Take reading just as arm leaves brush. Adjust tension for both brushes to figures specified (par. 22 **b**) by removing brush arm, spring, and bending spring. Install brush arm and spring. NOTE: *Always remove brushes from holders before removing head from armature. If brushes are left in holders they will snap down and may become chipped or cracked* (fig. 46).

(7) Pack plain and semi-shielded ball bearings ½ full with high temperature grease and soak felt washers, wicks and bronze bearings, if used, in engine oil (SAE 30). Keep oil from brushes and holders and drain off excess oil from bearings and felts.

d. Drive End Head.

(1) Inspect head for cracks and inspect retainers for distortion. Discard if these conditions are found. Discard bearing if it is worn or damaged. Discard felt washers if ragged or gritty.

(2) Install bearing in head. It should fit easily without looseness or binding. Discard head if bearing is loose.

(3) Discard shielded and sealed bearings if they are improperly lubricated and if they do not turn freely without binding or grating.

(4) Pack plain and semi-shielded ball bearings ½ full with high temperature grease. Soak felt washers in engine oil (SAE 30) and drain off excess oil.

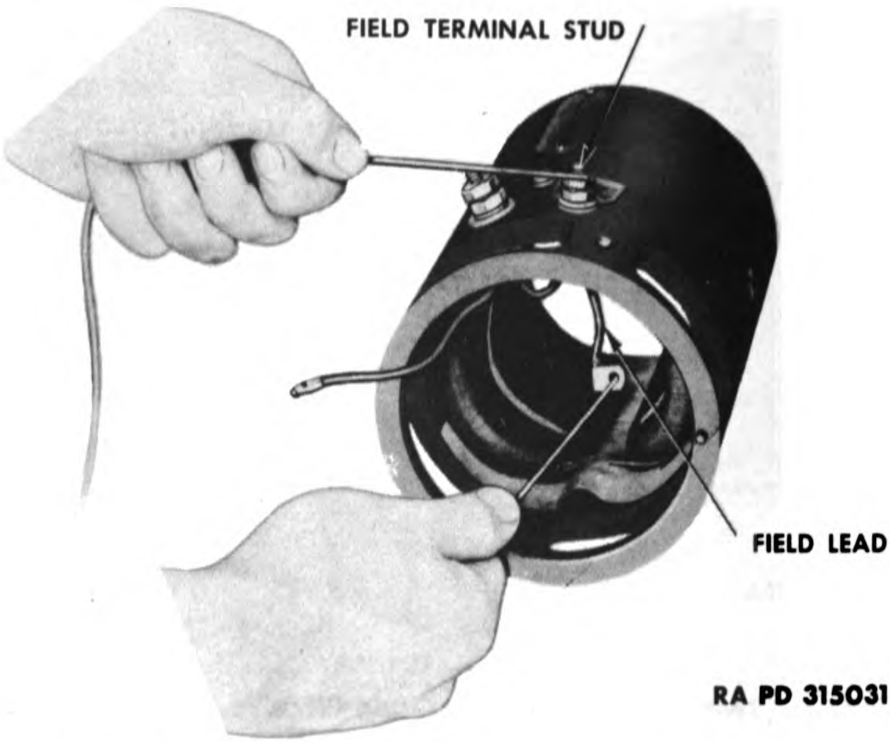


Figure 42—Testing Field Coils for Open Circuits with Test Probes—Group 2B Generators

(5) Install bearing, retainers, and washers, in head and install holding screws and lock washers. Tighten screws and inspect retainers to make sure they fit tightly against head.

e. Miscellaneous Parts. Inspect all parts for wear, cracks, and distortion, and replace any part that will not give satisfactory service.

19. REPAIR AND REBUILDING OF COMPONENTS.

a. Frame and Field Assembly.

(1) Replace defective leads, terminals, terminal posts, and insulation.

(2) If a coil tests open, shorted or grounded, unsolder connection between the two coils and disassemble terminal post from frame if it is soldered to faulty coil. Mark pole shoe position so shoes can be installed without interchanging or reversing. Take out pole shoe screw and remove faulty coil from frame.

(3) Solder terminal post to new coil using rosin core solder.

(4) Install field coil on pole shoe and install in frame. Turn pole shoe to position noted before removing from frame. Dip pole shoe screw in boiled linseed oil and install. As screw is tightened, hit frame a few sharp blows with soft hammer to properly aline and settle pole shoe.

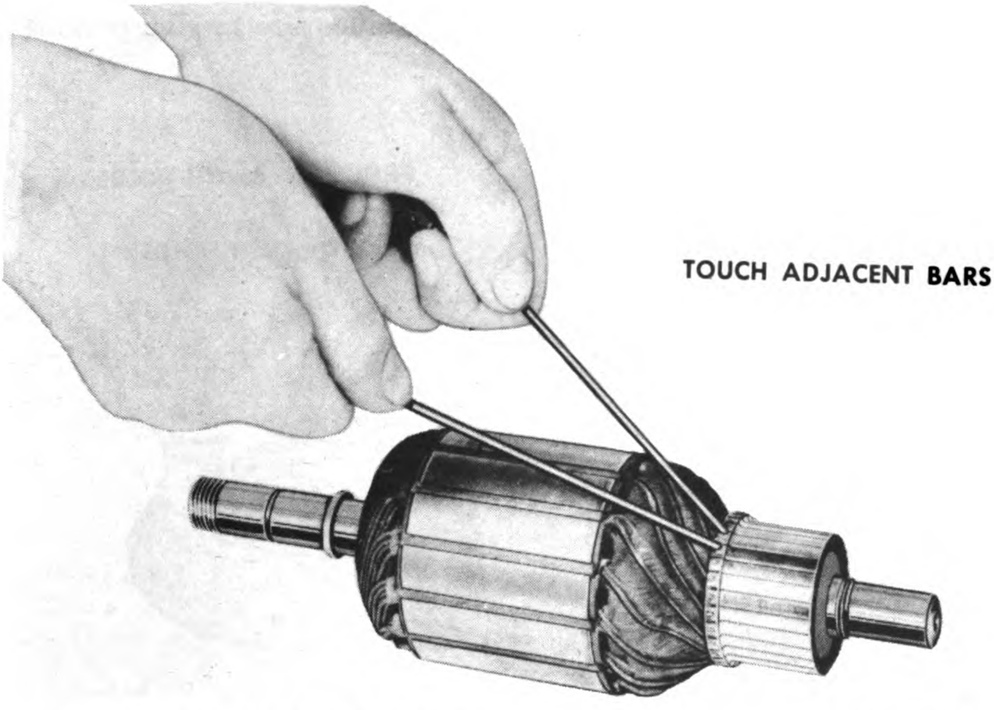


Figure 43—Testing Armature Coils for Open Circuits with Test Probes

(5) Twist and solder connection between two field coils.

(6) Assemble terminal stud and insulation in frame.

(7) On Group 2B generators, install and tighten field ground screw.

b. Armature.

(1) Do not attempt to repair armatures with worn or bent shafts, badly scored core, shorted or open windings, or badly burned and scored commutator.

(2) If commutator is rough or worn or if run-out exceeds 0.0005 inch place armature in lathe. Mount armature on shaft bearing seats if lathe is so equipped, otherwise mount armature on shaft centers.

Take light cuts until commutator is completely cleaned up (fig. 22) then remove all burs with 2/0 flintpaper (fig. 23). Do not use armature if commutator finishes up smaller than diameter tabulated (par. 22 **b**). After turning commutator undercut mica to a depth of 1/32 to 3/64 inch (fig. 24). Cut must be square and free from burs (fig. 25). If commutator has been turned, check for grounds and shorts (par. 18 **b** (2) and (4)).

c. Commutator End Head.

(1) Discard head if brush holders or head are defective.

(2) To install new bronze bearing drive old bearing out with an arbor or bolt that rests on bearing but does not damage bearing bore. Install new bearing on correct arbor and press into place with an arbor press. The arbor must have diameter of correct size to give bearing dimension specified (par. 22 **b**).

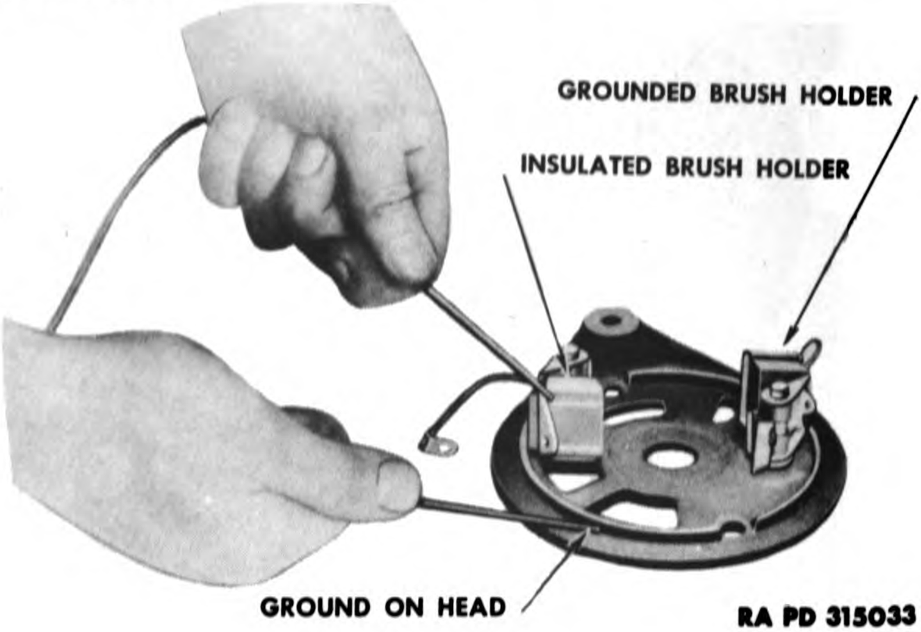


Figure 44—Testing Insulated Brush Holder for Grounds with Test Probes

(3) If new brushes have been installed cut a strip of 2/0 flintpaper the exact width of commutator. Place this strip under a brush with sanded side toward brush. Hold flintpaper so that it fits commutator and pull so that brush is forced toward holder (fig. 47). Once or twice is sufficient sanding to assure a perfect brush fit. Repeat this sanding on both brushes.

d. Drive End Head. There are no repairs to parts of drive end head other than to replace defective parts.

e. Miscellaneous Parts.

(1) Straighten cover band so that it will fit closely against frame without cracks. Replace band if it is badly bent.

(2) Replace screws, washers, and miscellaneous parts, if not in good condition.

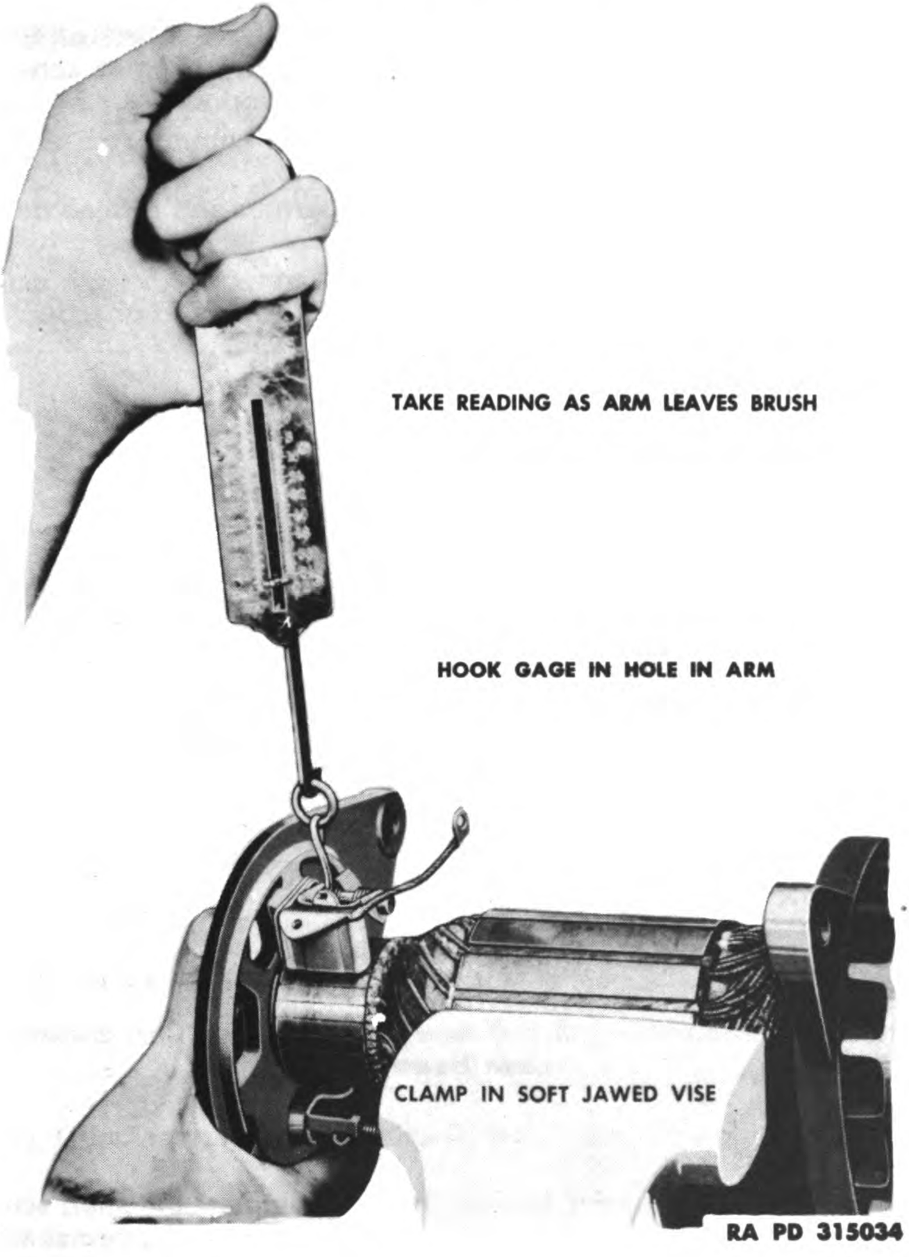


Figure 45—Measuring Brush Spring Tension on Group 2 Generators with Tension Gage (41-G-105)

20. ASSEMBLY.

a. Install Drive End Head on Armature.

(1) Place felt protector, if used, on armature shaft over snap ring.

(2) Press armature shaft into drive end head (fig. 27). Be sure shoulder or snap ring is down tight against bearing.

b. Install Armature in Frame and Field. Install armature in frame and field and turn drive end head so dowel pin enters hole in head.

c. **Install Commutator End Head.**

(1) On generators using through screws threaded on both ends, install screws in generator and tighten with pliers. Be sure one screw is installed under the loop in field connection installation (fig. 48).

(2) On GFM generators install bearing on commutator end of shaft.

(3) Install commutator end head on generator and turn so dowel pin fits into hole.

(4) Install but do not tighten through screws or through screw nuts and lock washer. Install one screw under field connection insulation (fig. 48).

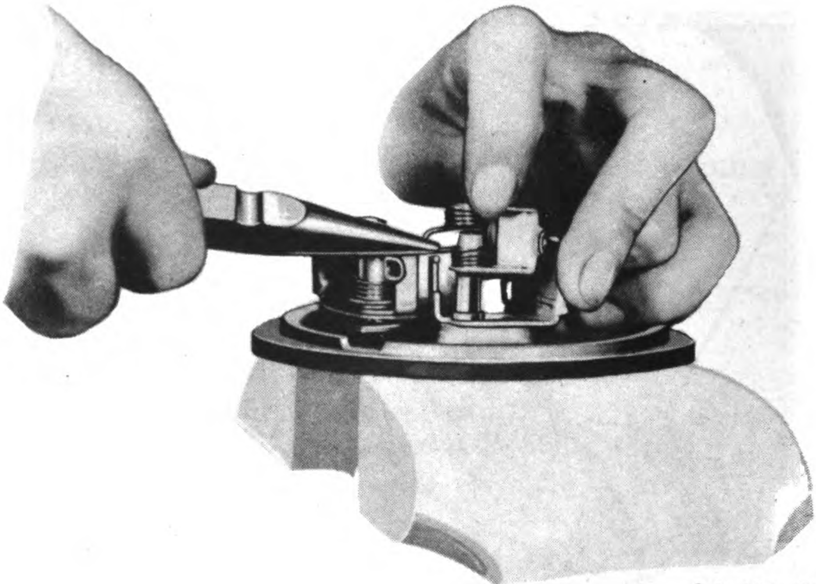


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Figure 46—Assembling Brush Arm and Spring on Commutator End Head

d. **Install Commutator End Bearing** (ball bearings only) (figs. 30, 37, and 38).

(1) Install felt washers, bearing, bearing retainer, and shaft screw or nut, on commutator end of shaft. Install semi-shielded bearings with shielded side on inside.

(2) Tighten through screws, strike frame one or two sharp blows with soft hammer as screws are tightened.

(3) Tighten shaft screw or nut.

e. **Install Commutator End Cover.**

(1) On bronze bearing type generators install oil wick in head and place it so that it lies on bottom of pocket (fig. 49).

(2) Install gasket and cover on generator and fasten with holding screws and lock washers (figs. 38 and 39).

f. **Install Air Deflector** (if pertinent). Install deflector on generator and fasten with attaching screws (fig. 37).

g. Install Fan on Commutator End (if pertinent) (fig. 37).

(1) Install Woodruff key in shaft.

(2) Install fan on shaft.

(3) Install and tighten lock washer and nut on shaft.

h. Install Drive Pulley or Gear.

(1) Install oil thrower on shaft.

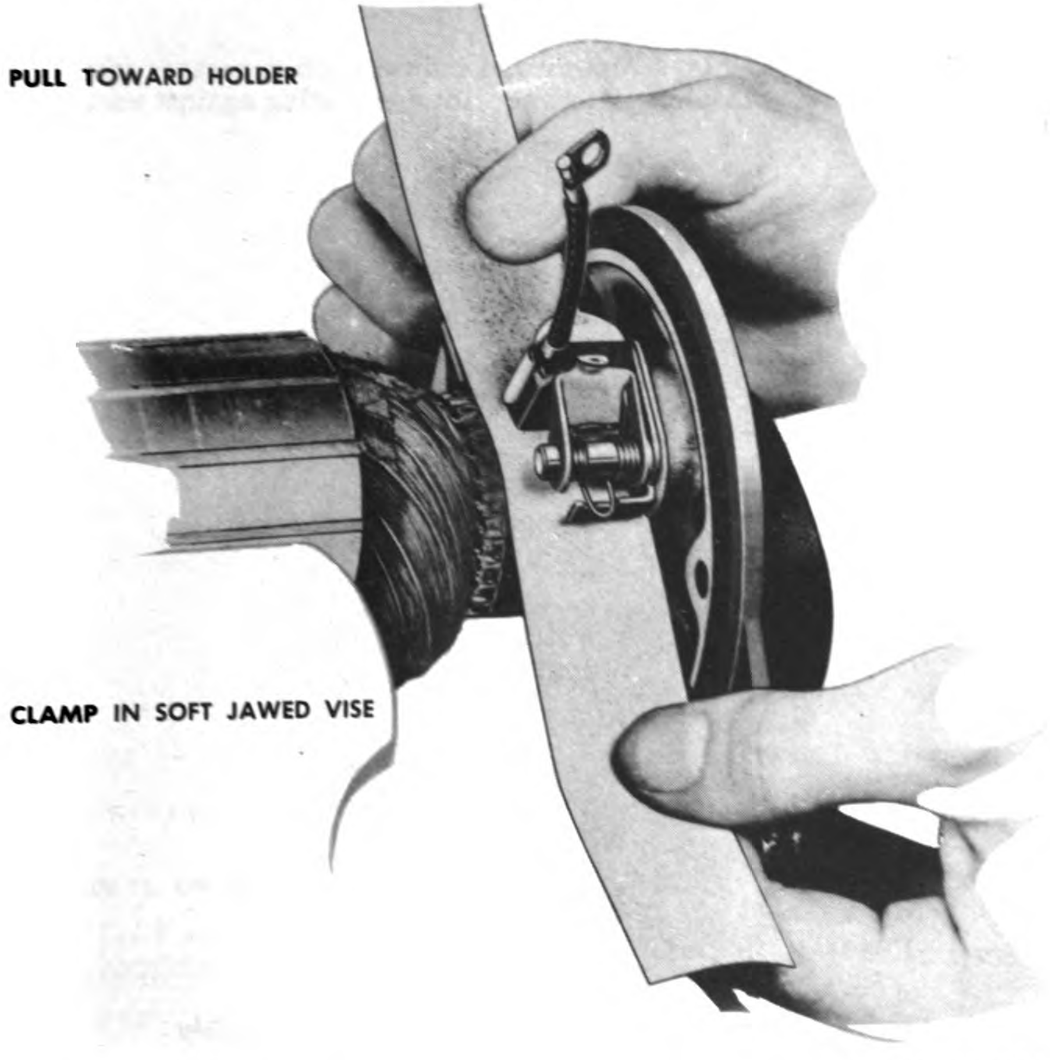

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Figure 47—Seating New Generator Brushes with 2/0 Flintpaper

(2) Install Woodruff key on shaft.

(3) Install pulley or gear on shaft.

(4) Install and tighten, plain washer, lock washer, and shaft nut.

(5) Install and spread cotter pin in shaft.

i. Install Brushes.

(1) Lift brush arms with hook (fig. 32) and install brushes in holders. Be sure brushes are turned so beveled face fits commutator.

(2) Connect brush leads to brush holders (fig. 33). At same time connect lead from armature terminal to insulated brush holder. Be sure screws have lock washers, then tighten securely.

(3) On GDM 4803 both terminal post lead and field coil lead must be connected to insulated brush holder.

(4) Check internal connections with internal wiring diagram (fig. 50).

21. TESTS AND ADJUSTMENTS.

a. **Measure End Play.** Mount dial indicator on generator frame or drive end head with plunger in line with and resting against end of

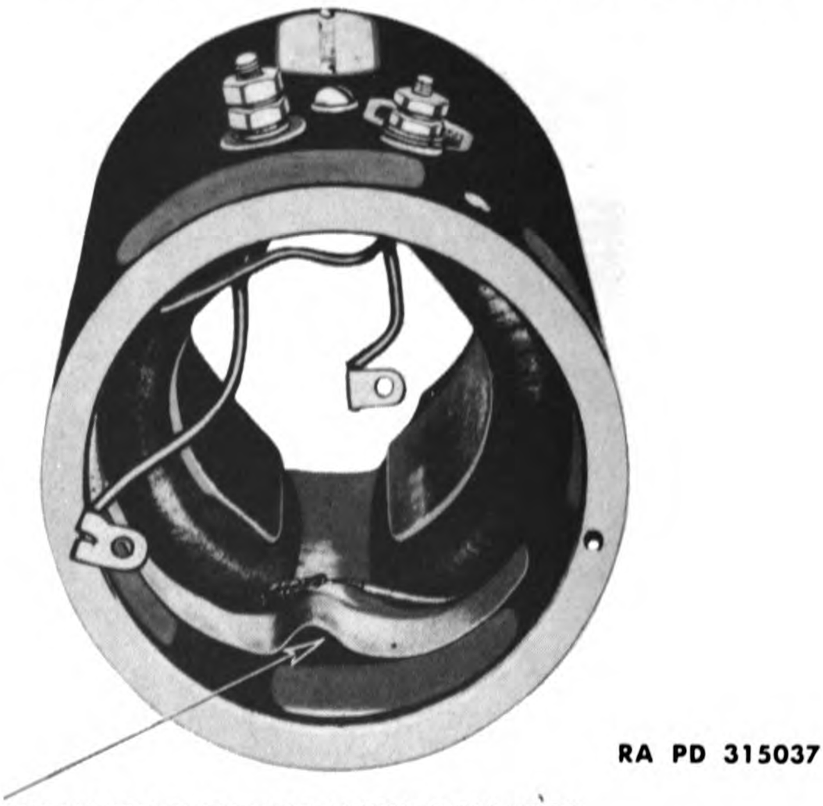

Figure 48—Generator Frame and Field Assembly

shaft (fig. 29). Move armature to its two extreme positions and read indicator. End play must be 0.003 inch to 0.010 inch. If it is not within these limits it indicates improper generator assembly. Inspect drive end and commutator end bearings for looseness in heads and make sure drive end bearing is down against snap ring or shoulder on shaft.

b. **Electrical Tests and Adjustments** (par. 24 c).

c. **Install Sleeve** (GEH 4806 only).

(1) Install spacer and drive sleeve on shaft.

(2) Center punch sleeve on shaft.

22. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Poles—2.

Brushes—2.

Lubrication—If generator is equipped with oilers add three to five drops of engine oil (SAE 30) every 100 hours of operation. Pack plain and semi-shielded ball bearings ½ full with high temperature

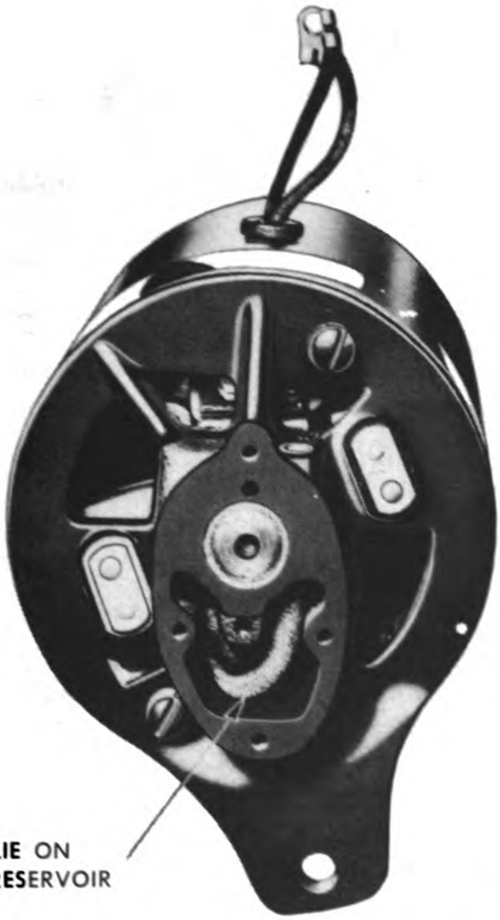

Figure 49—Position of Felt Wick in Oil Pocket

grease at assembly. Soak absorbent bronze bearings in engine oil (SAE 30) at assembly.

b. Mechanical.

Rotation—see tabulation (par. 22 d).

Brush length (new)

GDM, GEB, GEG, GEH, GEW, GFK, GFM, GGA types—15/16 inch.

GDZ, GEA—⅞ inch.

Brush length (worn)

All—½ inch minimum.

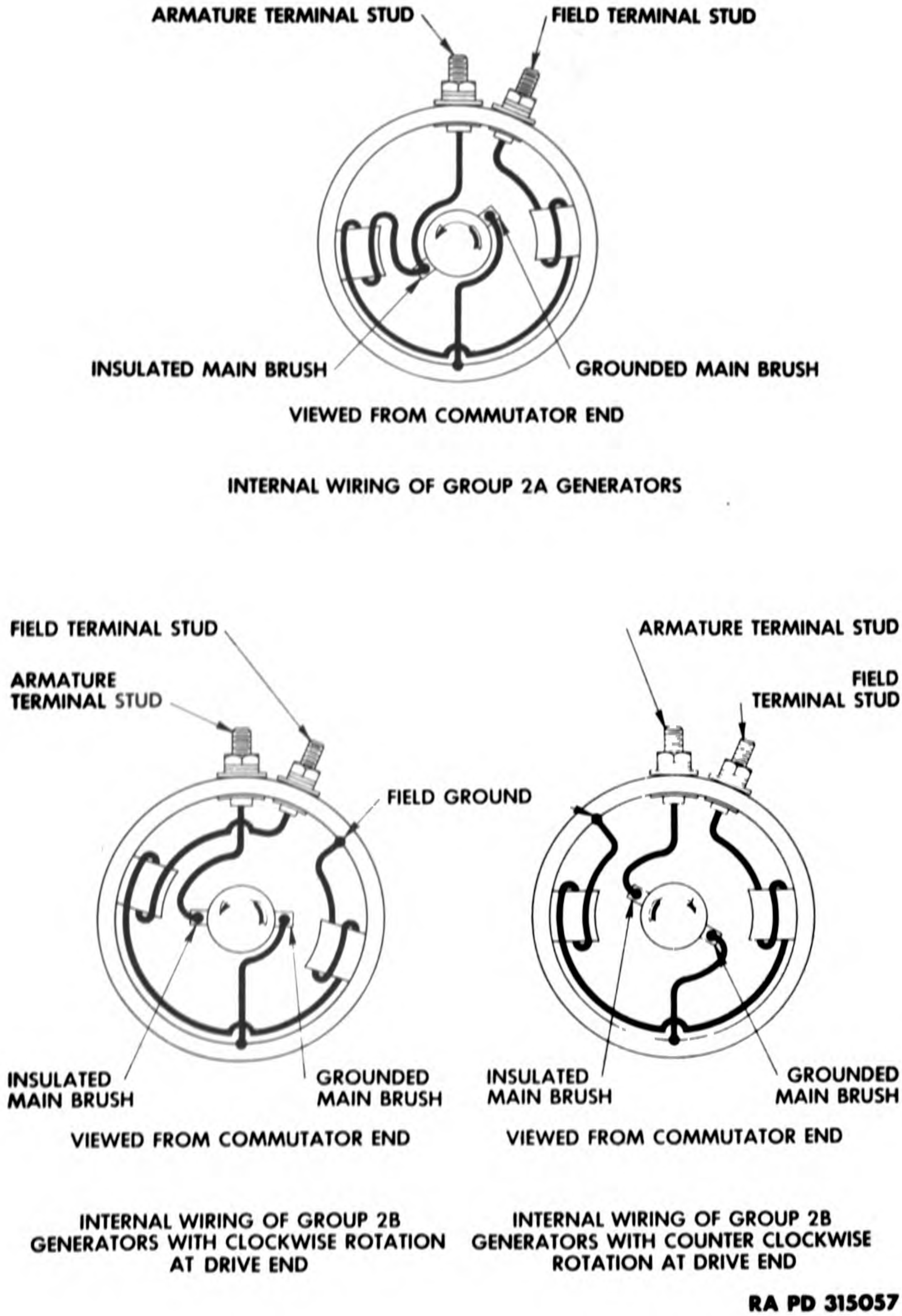

Figure 50—Internal Wiring Diagrams of Group 2 Generators

GENERATORS—GROUP 2

Commutator diameter (new)
GDM, GFK, GFM, GGA types—2.250 inches.
GDZ, GEA types—1.6875 inches.
GEB, GEG, GEH, GEW types—1.9375 inches.

Commutator diameter (worn)
GDM, GFK, GFM, GGA types—2.150 inches minimum.
GDZ, GEA types—1.60 inches minimum.
GEB, GEG, GEH, GEW types—1.85 inches minimum. NOTE: *Can be used at smaller diameters if arcing at brushes is not excessive at full output.*

Brush spring tension with new brushes
GDM, GFK, GFM, GGA types—30 to 37 ounces.
GDZ, GEA types—53 ounces maximum.
GEB, GEG, GEH, GEW types—64 to 68 ounces.

End play—0.003 to 0.010 inch.

Commutator run-out—total reading—0.0005 inch maximum.

Commutator mica undercut—1/32 to 3/64 inch.

Bearing diameter—Bronze bearings only—0.626 to 0.627 inch inside diameter after assembly in head.

c. **Electrical.**

Rated volts—see tabulation (par. 22 **d**).

Ground polarity—see tabulation (par. 22 **d**).

Control—Separately mounted current and voltage regulator.

Field fuse—None.

Field draw—Complete set of coils.
GDM, GFK types—1.5 to 1.7 amperes at 13.0 volts.
GDZ, GEA, GEB, GEG, GEW types—1.6 to 1.8 amperes at 6.0 volts.
GEH, GFM types—1.4 to 1.6 amperes at 13.0 volts.
GGA type—1.5 to 1.6 amperes at 13.0 volts.

Motorizing draw
GDM type—3.3 to 3.7 amperes at 13.0 volts.
GDZ type—4.1 to 4.6 amperes at 6.0 volts.
GEA type—4.4 to 4.9 amperes at 6.0 volts.
GEB type—4.4 to 4.5 amperes at 6.0 volts.
GEG type—4.7 to 5.2 amperes at 6.0 volts.
GEH type—3.3 to 3.7 amperes at 13.0 volts.
GEW type—3.2 to 3.6 amperes at 6.0 volts.
GFK type—3.3 to 3.7 amperes at 13.0 volts.
GFM type—6.1 to 6.7 amperes at 13.0 volts.
GGA type—2.9 to 3.2 amperes at 13.0 volts.

Maximum output—see tabluation (par. 22 **d**).

Internal wiring—figure 50.

Test hookups—see tabulation (par. 22 **d**).

d. Tabulated Specifications.

Generator	Volts	Rotation	Ground Polarity	Max Output* Volts	Max Output* Amps	Max RPM	Test Hook-ups
GDM 4803-1	12	CW	Pos	15.0	30.0	1500	Fig. 35
GDM 4803-1N	12	CW	Neg	15.0	30.0	1500	Fig. 35
GDM 5001-2	12	CW	Neg	15.0	35.0	1700	Fig. 36
GDZ 4801	6	CW	Pos	08.0	30–37	1900	Fig. 35
GDZ 4801A	6	CW	Pos	08.0	30–37	1900	Fig. 35
GDZ 4801B	6	CW	Pos	08.0	30–37	1900	Fig. 35
GDZ 4801C	6	CW	Pos	08.0	30–37	1900	Fig. 35
GDZ 4801D	6	CW	Pos	08.0	30–37	1900	Fig. 35
GEA 4802A-1	6	CW	Pos	08.0	35.0	1800	Fig. 35
GEB 4810	6	CW	Pos	08.0	32.0	1250	Fig. 35
GEG 5001A	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEG 5002	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEG 5002A	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEG 5002B	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEG 5002C	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEG 5002D	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEG 5002E	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEG 5002F	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEG 5004A	6	CW	Neg	08.0	40.0	1550	Fig. 36
GEH 4806	12	CW	Pos	15.0	17.0	1225	Fig. 35
GEH 5002-2	12	CCW	Pos	15.0	26.0	1500	Fig. 36
GEH 5002-2N	12	CCW	Neg	15.0	26.0	1500	Fig. 36
GEW 4802	6	CW	Pos	08.0	25.0	1050	Fig. 36
GEW 4803	6	CW	Pos	08.0	25.0	1050	Fig. 36
GEW 4803A	6	CW	Pos	08.0	25.0	1050	Fig. 36
GEW 4804	6	CW	Pos	08.0	25.0	1050	Fig. 35
GEW 4805	6	CCW	Pos	08.0	25.0	1050	Fig. 36
GEW 4806	6	CW	Pos	08.0	25.0	1050	Fig. 36
GEW 4806A	6	CW	Pos	08.0	25.0	1050	Fig. 36
GEW 4806B	6	CW	Pos	08.0	25.0	1050	Fig. 36
GEW 4806C	6	CW	Pos	08.0	25.0	1050	Fig. 36
GFK 4801	12	CCW	Pos	15.0	30.0	1500	Fig. 36
GFM 4801	12	CW	Neg	15.0	50.0	1900	Fig. 36
GFM 4801A	12	CW	Neg	15.0	50.0	1900	Fig. 36
GGA 4801A	12	CW	Neg	15.0	40.0	1600	Fig. 36

*Do not operate at higher outputs and do not operate at this output without ventilating fan as there is danger of burning armature and fields.

CW—Clockwise rotation at drive end.

CCW—Counterclockwise rotation at drive end.

Neg—Negative ground.

Pos—Positive ground.

CHAPTER 2

GENERATORS (Cont'd)

Section IV

GENERATORS—GROUP 3

23. DESCRIPTION AND DATA.

a. Description.

(1) Group 3 generators are four pole brush units with the output controlled by a separately mounted current and voltage regulator. Figure 51 is a disassembled view of a typical Group 3 generator showing the main components and their attaching parts.

(2) These generators have no internal regulation incorporated in their design and must be used with the regulator designed to operate with the generator. The data tabulation (par. 23 **b**) shows the original equipment regulator for use with each generator. Do not substitute. Some substitutions will operate satisfactorily for a short period but regulators will soon fail if used with the incorrect generator.

(3) For model numbers of Group 3 generators, see paragraph 1.

b. Data.

Generator	Rated Volts	Rotation	Ground Polarity	Field Draw Volts	Field Draw Amperes	Motorizing Draw Volts	Motorizing Draw Amperes	Output* Volts	Output* Amperes	Max RPM	Regulator Used With
GBG 4601	12	CW	Pos	13.0	1.4 to 1.5	13.0	4.0 to 4.4	15.0	40.0	1150	VRA 4102A
GBG 4612	12	CCW	Neg	13.0	1.4 to 1.5	13.0	4.0 to 4.4	15.0	40.0	1150	VRA 4105A
GDJ 4802A	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4102A
GDJ 4804	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4104A-1
GDJ 4804A	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4104A-1
GDJ 4804B	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4104B-1
GDJ 4804C	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4104B-1
GDJ 4808	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4104A-1
GDJ 4808A	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4104A-1
GDJ 4809A	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4102A
GDJ 4809B	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4102A
GDJ 4812A	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4106A
GDJ 4819A	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4102A
GDJ 4820A	12	CW	Neg	13.0	1.5 to 1.7	13.0	7.6 to 8.4	15.0	55.0	1200	VRH 4104C-1
GFZ 4801A	24	CW	Neg	26.0	0.9 to 1.0	26.0	2.9 to 3.2	30.0	25.0	950	VAL 4101A
GFZ 4801B	24	CW	Neg	26.0	0.9 to 1.0	26.0	2.9 to 3.2	30.0	25.0	950	VAL 4101A

CW—Clockwise rotation at drive end. CCW—Counterclockwise rotation at drive end. Neg—Negative ground. Pos—Positive ground

*Do not operate at this output without ventilating fan, and do not operate at higher outputs as it will overheat generator and may burn armature and fields.

24. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Remove terminal shield cover from shielded generators.

(2) Wipe outside of generator with cloth dampened in dry-cleaning solvent. Make sure terminals and pulley are clean. Do not allow dry-cleaning solvent to enter generator.

b. Inspecting.

(1) Inspect frame, end heads, drive pulley and fan, for wear and cracks. If any part is cracked, disassemble generator and discard defective part. Discard drive pulley if cracked or broken or if belt surface is rough. Install new fan if blades are broken or cracked.

(2) Remove clamp screw and lift cover band from generator.

(3) Lift brush arms with hook and take brushes out of holders (figs. 32 and 52). Blow off brush holders and commutator with clean dry compressed air. If brush holders are dirty, gummy, or corroded, overhaul generator (pars. 25 to 31). Install new brushes if brushes are oil soaked or worn to less than ½ inch in length. To install new brushes disconnect brush lead from holder (figs. 33 and 53). Assemble new brushes in holders with beveled face turned to fit commutator (figs. 32 and 52). Connect brush leads to holders and on GDJ and GFZ types also connect field coil and terminal post leads to brush holders. Hold brush arm up with hook and try fit of brushes in holders. If brushes do not slide freely without sticking, overhaul generator (pars. 25 to 31). Inspect alinement of brushes on commutator. If edges of brushes are not in perfect alinement with commutator segments, overhaul generator and discard head or brush plate (pars. 25 to 31).

(4) If commutator is rough or worn, disassemble generator and turn down commutator (par. 28 **b**). If commutator is only dirty or discolored clean by holding 2/0 flintpaper against it while turning armature slowly. Blow sand out of generator with clean dry compressed air.

(5) If new brushes have been installed, cut strip of 2/0 flintpaper the exact width of commutator. Place strip under a brush with sanded side toward brush. Hold flintpaper so that it fits contour of commutator and does not round edges of brush. Pull strip so brush is forced toward brush holder (figs. 34 and 54). Once or twice is sufficient as additional sanding merely shortens brush life. Sand all four brushes.

c. Testing.

(1) MEASURE FIELD COIL DRAW (fig. 36).

(a) Mount generator on test stand.

(b) Test stand battery must be fully charged and of same rated voltage as generator. Connect voltmeter lead and one test stand battery lead to generator field terminal stud. Connect other battery and voltmeter leads to generator frame.

(c) Close test stand battery switch and adjust rheostat so voltage is value specified (par. 23 **b**). Current must be within limits specified (par. 23 **b**). Any other reading indicates faulty field coils or connections and necessitates complete generator overhaul (pars. 25 to 31).

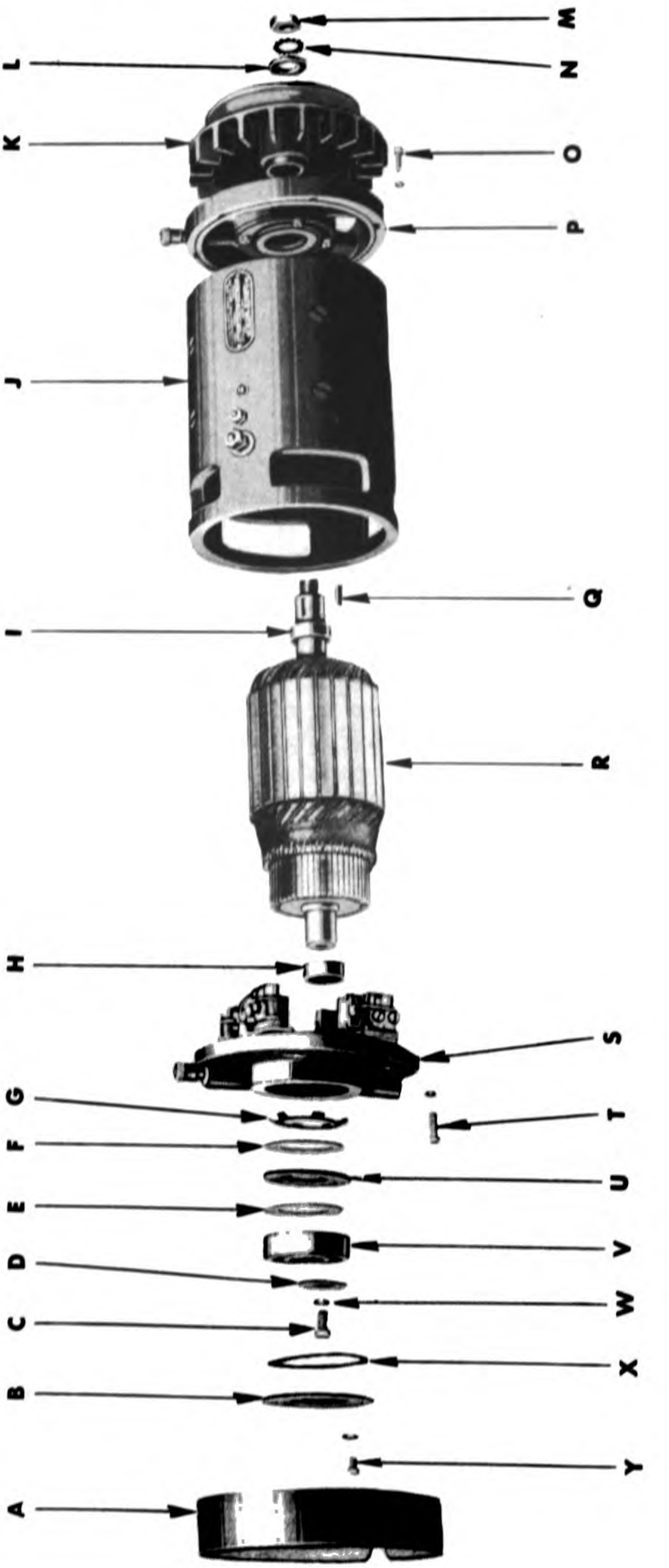

Figure 51—Main Components of Group 3 Generators

GENERATORS—GROUP 3

A—COVER BAND
B—COMMUTATOR END COVER
C—BEARING RETAINING SCREW
D—BEARING RETAINING WASHER
E—FELT RETAINING WASHER
F—FELT RETAINING WASHER
G—SPRING WASHER
H—SHAFT SPACER
I—SHAFT SPACER
J—FRAME AND FIELD ASSEMBLY
K—DRIVE PULLEY
L—SHAFT PLAIN WASHER
M—SHAFT NUT
N—SHAFT LOCK WASHER
O—DRIVE END HEAD ATTACHING SCREW
P—DRIVE END HEAD ASSEMBLY
Q—WOODRUFF KEY
R—ARMATURE
S—COMMUTATOR END HEAD ASSEMBLY
T—COMMUTATOR END HEAD ATTACHING SCREW
U—FELT WASHER
V—COMMUTATOR END BALL BEARING
W—BEARING RETAINING SCREW LOCK WASHER
X—COVER GASKET
Y—COVER ATTACHING SCREW

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Legend for Figure 51—Main Components of Group 3 Generators

(d) Open test stand battery switch.

(e) Disconnect leads from generator.

(2) MEASURE MOTORIZING DRAW (fig. 36).

(a) Connect battery to test stand for correct polarity (par. 23 **b**).

(b) Connect battery ground lead to generator frame, and connect other battery lead to generator armature terminal. Connect voltmeter from generator frame to generator armature terminal. Connect jumper lead from field terminal to armature terminal.

(c) Close test stand battery switch. Generator must operate as a motor with armature turning slowly.

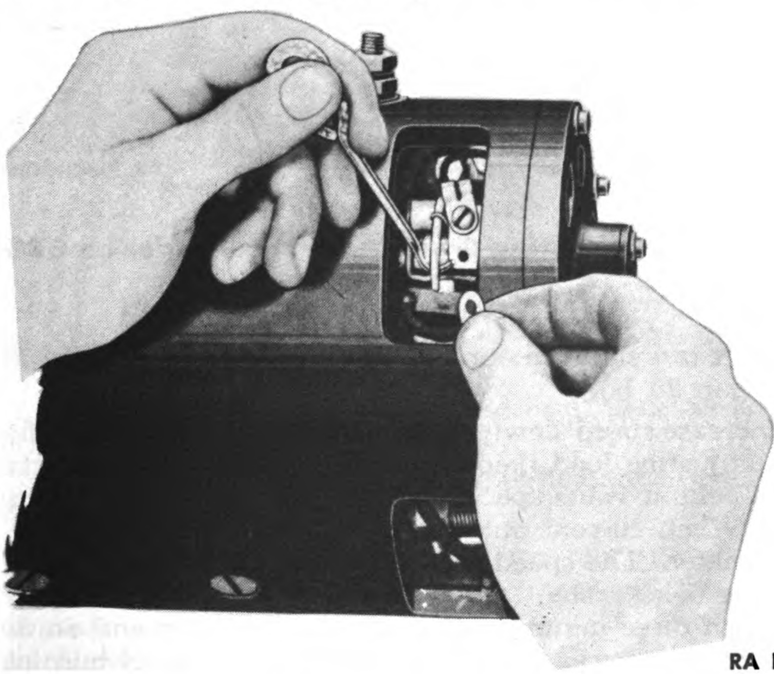

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Figure 52—Removing Brush from Holder on GBG-type Generators

(d) Adjust voltage to value specified (par. 23 **b**) and read ammeter. If current is not within specifications (par. 23 **b**) it indicates worn bearings, incorrect bearing alinement, shorts or improper generator assembly. Overhaul generator if these conditions are present (pars. 25 to 31).

(e) Open test stand battery switch.

(3) CHECK GENERATOR OUTPUT (fig. 36).

(a) With generator connected as above for motorizing test (par. 15 **c** (2) above) connect armature shaft to test stand motor with coupling.

(b) Close test stand battery switch.

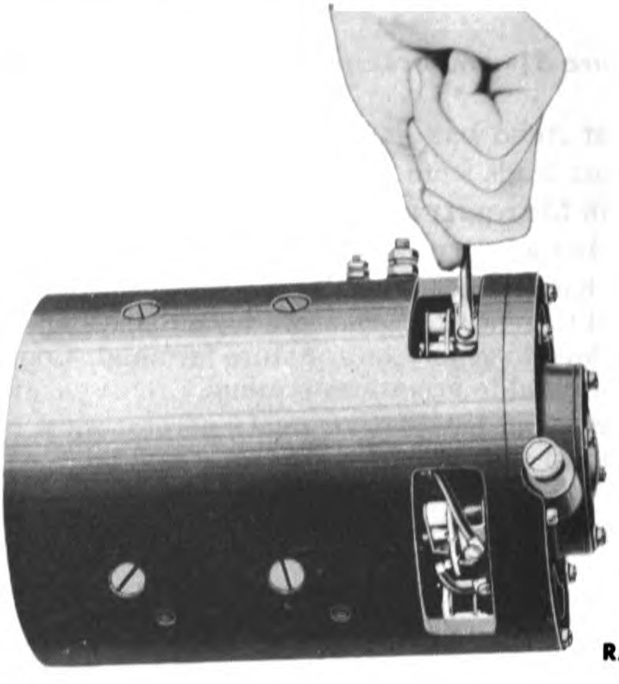

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Figure 53—Disconnecting Brush Lead from Holder on GBG-type Generators

(c) Start test stand motor so that generator is driven in direction specified (par. 23 **b**).

(d) Increase speed slowly, keeping voltage at value specified (par. 23 **b**) by adjusting load rheostat across battery. It is important that voltage be held at value specified. Note ammeter reading as speed is increased. When current output reaches value specified (par. 23 **b**) read tachometer. The speed should not be more than value specified for generator being tested (par. 23 **b**). Do not operate in this manner for more than three minutes without ventilating fan and do not operate at higher voltages and current, as there is danger of burning armature and fields. If output cannot be obtained or if speed is too high, it indicates high resistance connections, dirty commutator, worn or oil

soaked brushes, poor brush contact, or improper brush plate assembly. Faulty coils or armature also cause incorrect readings.

(4) LUBRICATION.

(a) Add three to five drops of engine oil (SAE 30) to each oiler. Some group 3 generators have sealed bearings and require no additional lubrication.

(b) Place cover band around generator and turn so all inspection holes are covered. Install and tighten clamp screw and nut.

25. DISASSEMBLY.

a. Remove Cover Band. Take out clamp screw and nut and lift band from generator.

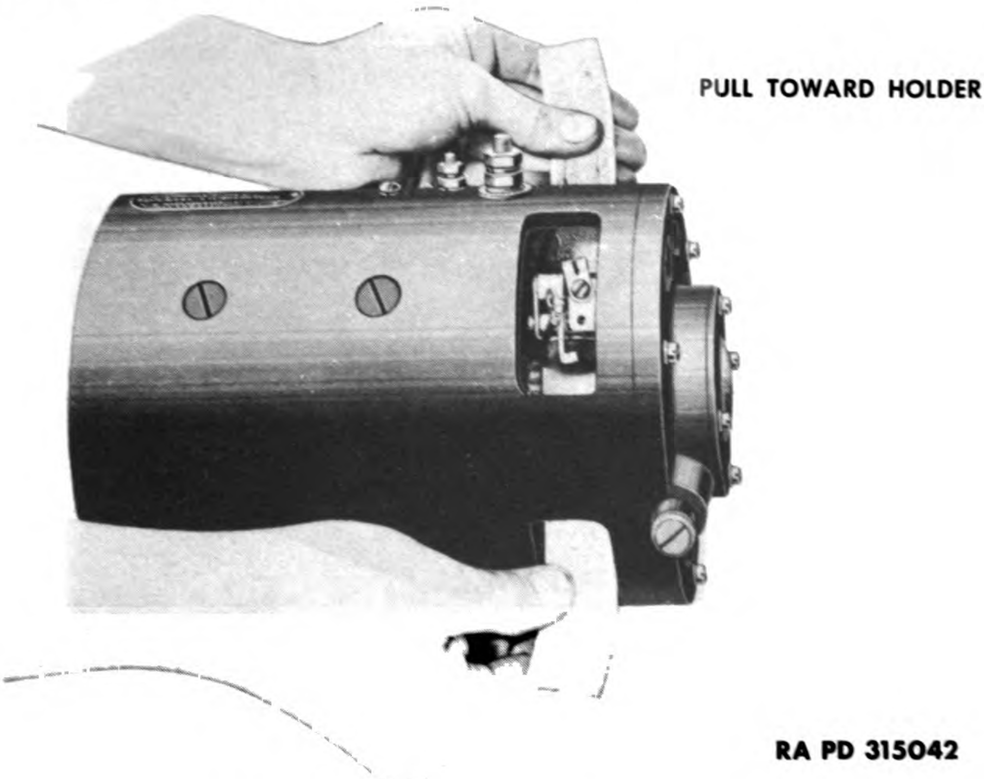

Figure 54—Seating New Generator Brushes with 2/0 Flintpaper

b. Remove Shaft Nut. Take off shaft nut, lock washer, and plain washer.

c. Remove Drive Pulley. Remove pulley, then remove Woodruff key from shaft.

d. Remove Fan (if pertinent).

(1) On generators with separate pulley and fan remove snap ring on shaft between pulley and fan.

(2) Remove fan, then remove Woodruff key from shaft.

e. Remove Shaft Sleeve and Oil Thrower (GBG 4601 only).

(1) Pry sleeve from shaft.

(2) Unscrew oil thrower from shaft.

f. Remove Commutator Cover. Take out four screws and lift off cover and gasket (fig. 55).

g. Remove Leads from Brush Holders.

(1) Remove brush lead screw from brush holders (figs. 33 and 53).

(2) On GBG-type generators disconnect field coil and terminal stud leads from brush holders.

h. Remove Commutator End Shaft Screw. Take out shaft screw and washer (fig. 55).

i. Remove Commutator End Head.

(1) With straightedge and sharp point, mark relationship between head and frame.

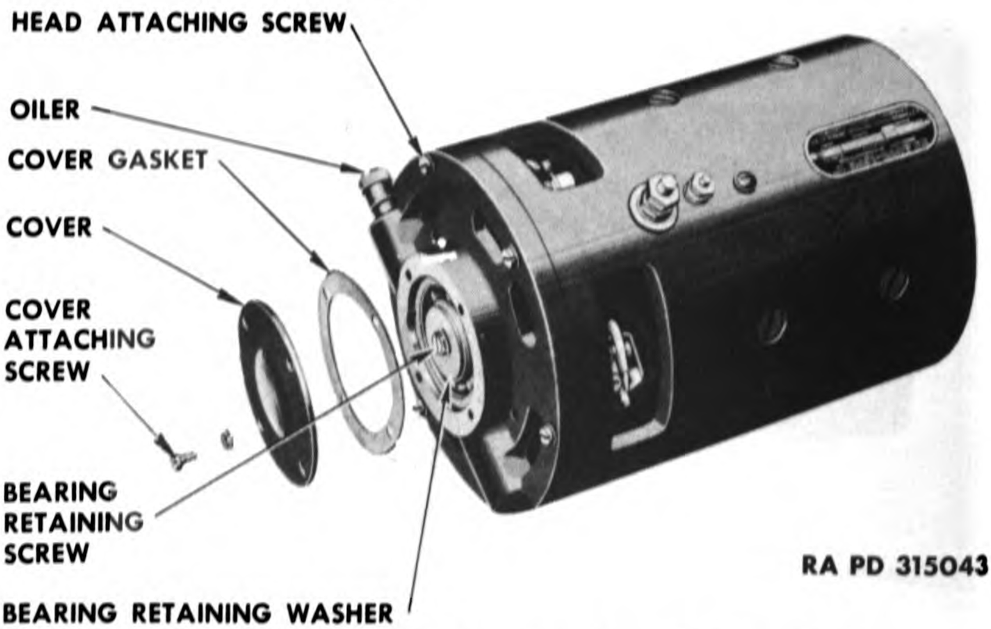

Figure 55—Commutator End Construction of Group 3 Generators

(2) Take out head attaching screws and lock washers (fig. 55).

(3) Tap head lightly with soft hammer and remove head from generator.

(4) Press bearing and washers out of head with fingers.

(5) Take shaft spacer off commutator end of shaft.

j. Remove Drive End Head and Armature.

(1) With straightedge and sharp point mark position of head in relation to frame.

(2) Take out drive end head attaching screws and lock washers.

(3) Lift drive end head and armature out of frame and field.

k. Remove Armature from Drive End Head.

(1) Press shaft out of head with arbor press (fig. 11).

(2) Remove shaft spacer from armature shaft.

26. CLEANING OF COMPONENTS.

a. Frame and Field Assembly. Clean frame and field assembly with cloth dampened in dry-cleaning solvent. Do not soak in dry-cleaning solvent and be careful not to damage insulation or leads. Blow dry with clean dry compressed air.

b. Armature. Blow off all loose dirt with compressed air. Wipe armature with clean cloth dampened in non-oily dry-cleaning solvent. Sand commutator with 2/0 flintpaper. Do not handle commutator. Clean dirt from between commutator bars but do not damage or form burs on bars or mica.

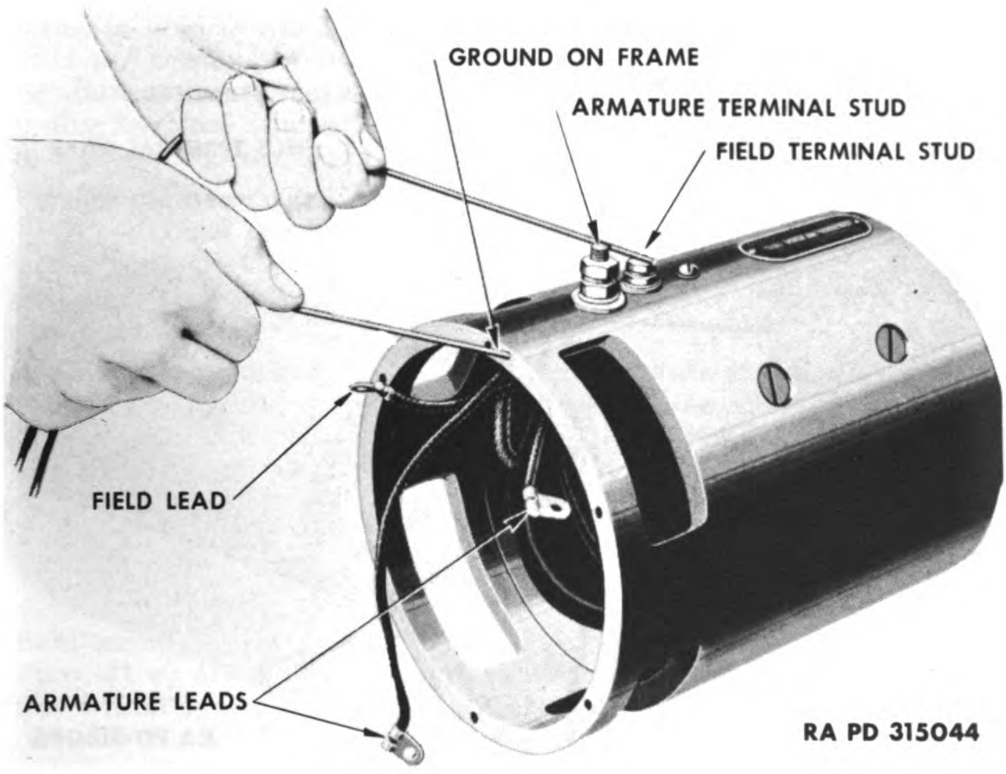

Figure 56—Testing Field Coils for Grounds with Test Probes—Group 3 Generators

c. Commutator End Head.

(1) Unscrew oiler from side of head and remove felt wick, if used.

(2) On GBG-type generators mark with straightedge and sharp point position of brush plate in relation to head. Remove three screws and lift plate from head.

(3) Soak head and brush holders in dry-cleaning solvent and clean with soft rag. Dry with compressed air and remove all lint.

(4) Wipe brushes with clean dry rag.

(5) Wipe fully shielded or sealed bearings clean with rag dampened in dry-cleaning solvent. Do not soak as these bearings cannot be

repacked with grease. Soak semi-shielded and plain bearings in dry-cleaning solvent and clean thoroughly. Dry bearing with clean compressed air but do not spin bearing.

(6) Wipe felt washers and wicks clean with rag.

(7) Soak retainers, covers, and gaskets, in dry-cleaning solvent and clean thoroughly.

d. Drive End Head.

(1) Take out bearing retainer screws and remove retainers, felt washers, and bearing. Press felt washer and felt retainer out of bearing retainer. Remove oiler and felt wick if used.

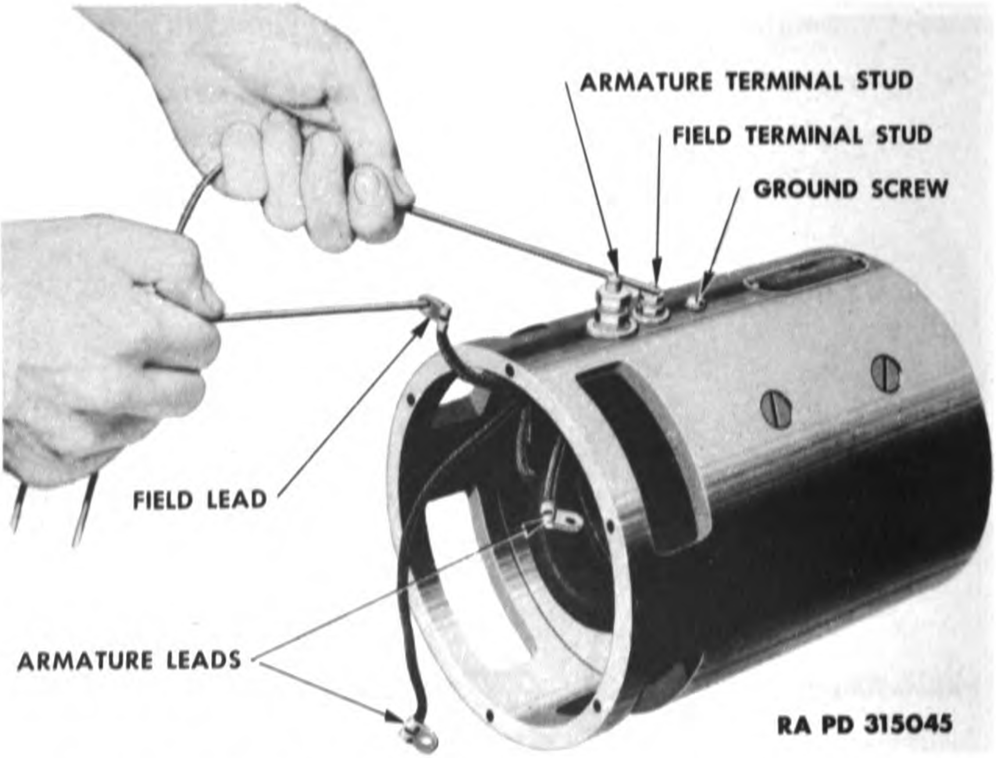

Figure 57—Testing Field Coils for Open Circuits with Test Probes—Group 3 Generators

(2) Soak head, oiler, gaskets, and retainers, in dry-cleaning solvent and clean with soft rag. Dry with compressed air. Remove all lint.

(3) Wipe fully shielded or sealed bearings clean with rag dampened in dry-cleaning solvent. Do not soak as these bearings cannot be repacked with grease. Soak semi-shielded and plain ball bearings in dry-cleaning solvent and clean thoroughly. Dry with clean compressed air; do not spin bearing.

(4) Wipe felt washers and wicks clean with a rag.

e. Miscellaneous Parts. Clean balance of parts in dry-cleaning solvent and dry thoroughly.

27. INSPECTION AND TEST OF COMPONENTS.

a. Frame and Field.

(1) Inspect frame and field for worn or frayed insulation, broken leads, and loose or corroded terminals. If any of these conditions are found repair or replace faulty parts (par. 28 **a**).

(2) If radio condenser is mounted on terminal stud, remove and check for grounds and capacity on condenser tester. Discard if grounded or if capacity is not within limits (par. 31 **c**).

(3) Check field coils for grounds with test probes consisting of lamp in series with two points and source of electricity (fig. 12). Make sure no leads are touching frame; touch one test probe to frame and other to field terminal stud (fig. 56). If coils test grounded, remove nuts and washers from field terminal stud and press stud out of frame. Again test coils for grounds. If coils are not grounded it indicates faulty terminal stud insulation which must be replaced. If coils still test grounded, unsolder connections between field coils and test each coil separately. Replace grounded coil (par. 28 **a**).

(4) Touch one test probe to field terminal stud and other test probe to the field coil lead (fig. 57). If lamp does not light test each coil separately by touching the two ends of each coil. Replace open coil (par. 28 **a**).

(5) Touch armature stud with one test probe and touch each lead terminal with other probe. If lead is open, disassemble terminal stud from frame and install new lead. Make sure leads are not touching frame and touch test probes to armature terminal stud and to generator frame. If ground is present disassemble stud from frame and install new insulation.

(6) Connect ammeter, battery and variable resistance in series with field terminal stud and field coil lead. Connect voltmeter from field terminal stud to field coil lead. Adjust voltage to specified value (par. 31 **c**) and read ammeter. If current for complete set of coils is not within limits specified (par. 31 **c**) it indicates a short within a coil. To check which coil is shorted: connect battery, ammeter, and voltmeter, across each coil separately. Adjust voltage to specified value (par. 31 **c**) and read ammeter. Current must be four times current specified for complete set of coils. If current for any coil is not within limits replace shorted coil (par. 28 **a**).

b. Armature.

(1) Inspect armature to make sure all coils are properly pressed into core slots and are soldered to commutator risers. Replace armature if windings are loose or unsoldered. Inspect core for wear and replace armature if scored badly. Turn down commutator if rough or worn (par. 28 **b**). Inspect bearing seats for wear and replace armature if wear is evident.

(2) Touch one test probe to core or shaft and touch other probe to each commutator segment in turn (fig. 17). If ground is present, lamp will light. Do not touch probes to bearing or brush surface as an arc would mar the smooth finish. Replace armature if grounded.

(3) Touch test probes to each pair of adjacent commutator bars (fig. 43). Do not touch probes to brush surfaces. If lamp does not light it indicates an open. Repeat this test on every pair of adjacent bars and replace armature if open.

(4) Check armature for shorts. CAUTION: *Do not use usual growler and steel strip test as all GDJ- and GFZ-type armatures will*

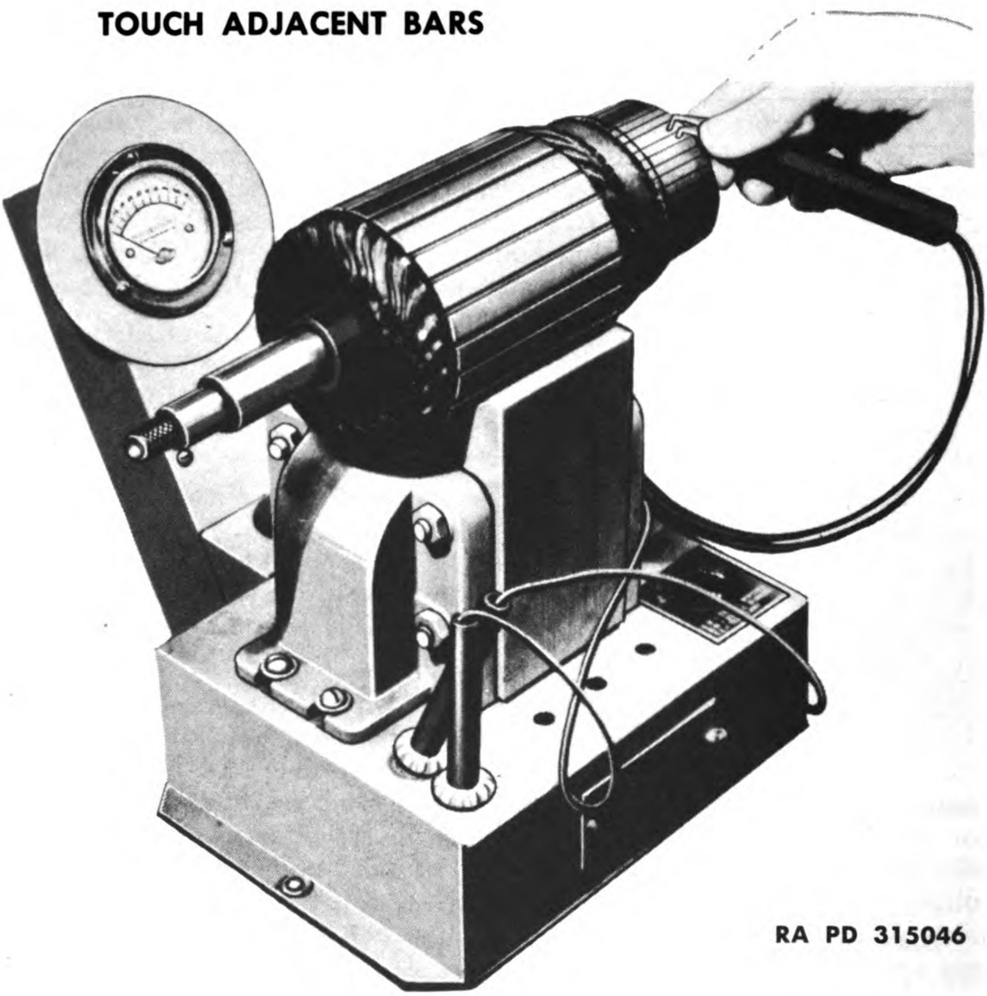

Figure 58—Testing Armature for Shorts with Growler (17-G-5940) and A-C Milliameter

test shorted by this method. GBG-type armatures may be checked either by following method or by growler test (par. 18 **b** (4)). Mount armature on growler and adjust two contacts to rest on adjacent commutator bars. Connect these contacts to an a-c milliammeter. Move the contacts around commutator until highest reading is obtained. When position of contacts is determined keep contacts in that location and turn armature to bring each pair of segments under contacts (fig. 58). Take a milliammeter reading for each pair of adjacent bars.

Readings should be nearly uniform for all readings. If a coil is shorted milliammeter reading will drop to almost zero. Replace armature if shorted.

(5) Place armature with bearing seats on "V" blocks and place dial indicator with plunger against commutator. Rotate armature and measure total indicator reading (fig. 19). If total reading is larger than 0.0005 inches, turn down commutator (par. 28 **b**).

c. Commutator End Head.

(1) Inspect head and parts for cracks and distortion and replace if these conditions are found. Replace felt washers and wicks if torn or gritty. Replace gasket if not in perfect condition. Install new

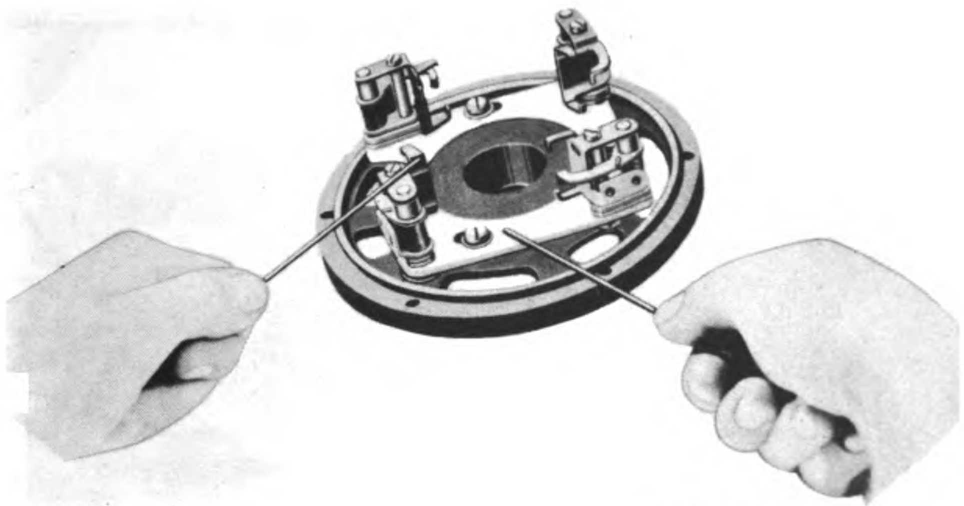

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Figure 59—Testing Insulated Brush Holders for Grounds with Test Probes

brushes if cracked, oil soaked, or worn to less than ½ inch long. Make sure brush leads and terminals are not frayed, broken, or corroded.

(2) On GBG-type generators install brush plate on head. Turn plate so that locating marks made during disassembly are alined, and tighten screws.

(3) With test probes check insulated brush holders for grounds (figs. 59 and 60). If ground is present, install new brush plate on GBG-type and replace complete head on GDJ and GFZ-type generators.

(4) Place armature in padded vise and install shaft spacer, commutator end head, spring washer, felt retainer, and bearing, on shaft. Press bearing into head. Feel side play in bearing. If any side movement can be felt it indicates worn bearing, worn shaft, or loose bearing fit, in head. Inspect to find cause of side play and replace parts affected.

(5) With head and bearing assembled on armature, install brushes in holders. Make sure beveled face fits commutator. If brushes do not

slide freely or if edges of brushes are not in perfect alinement with commutator segments install new brush holders on GBG-type generators or replace complete head on GDJ and GFZ-type generators.

(6) On GBG generators hook tension gage under brush arm (fig. 61) and on GDJ and GFZ-types hook tension gage in hole in end of brush arm (fig. 62). Pull gage on line parallel to face of brush and take reading just as arm leaves brush. Adjust tension for all brushes to limits specified (par. 31 **b**) by removing brush arm and spring and bending spring.

(7) Pack plain and semi-shielded ball bearings ½ full with high temperature grease and soak felt washers and wicks in engine oil (SAE 30). Keep oil away from brushes or holders and drain off excess oil.

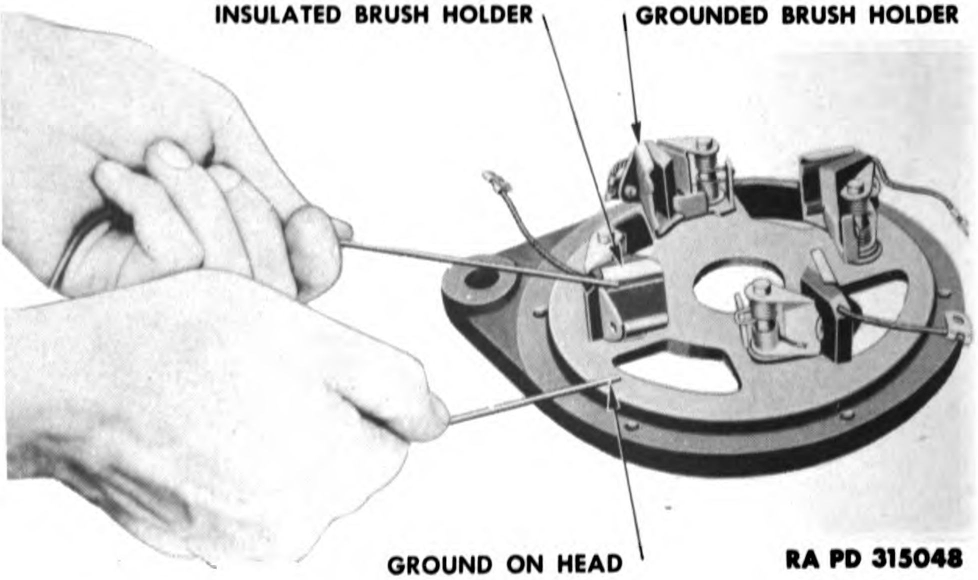

Figure 60—Testing Insulated Brush Holders for Grounds with Test Probes

d. Drive End Head.

(1) Inspect head for cracks and inspect retainers for distortion. Replace if defective. Replace bearing if worn or damaged or if seal type bearing lacks lubricant. Replace felt washers and wicks if torn, ragged, or gritty.

(2) Install bearing in head. Bearing must fit easily without looseness or binding. Replace head if bearing is loose.

(3) Pack semi-shielded and plain ball bearings ½ full with high temperature grease and soak felts in engine oil (SAE 30). Drain off excess oil.

(4) Install bearing, retainers, and washers, in head. Install and tighten holding screws and lock washers. NOTE: *Semi-shielded bearings must be assembled with shielded side toward armature.*

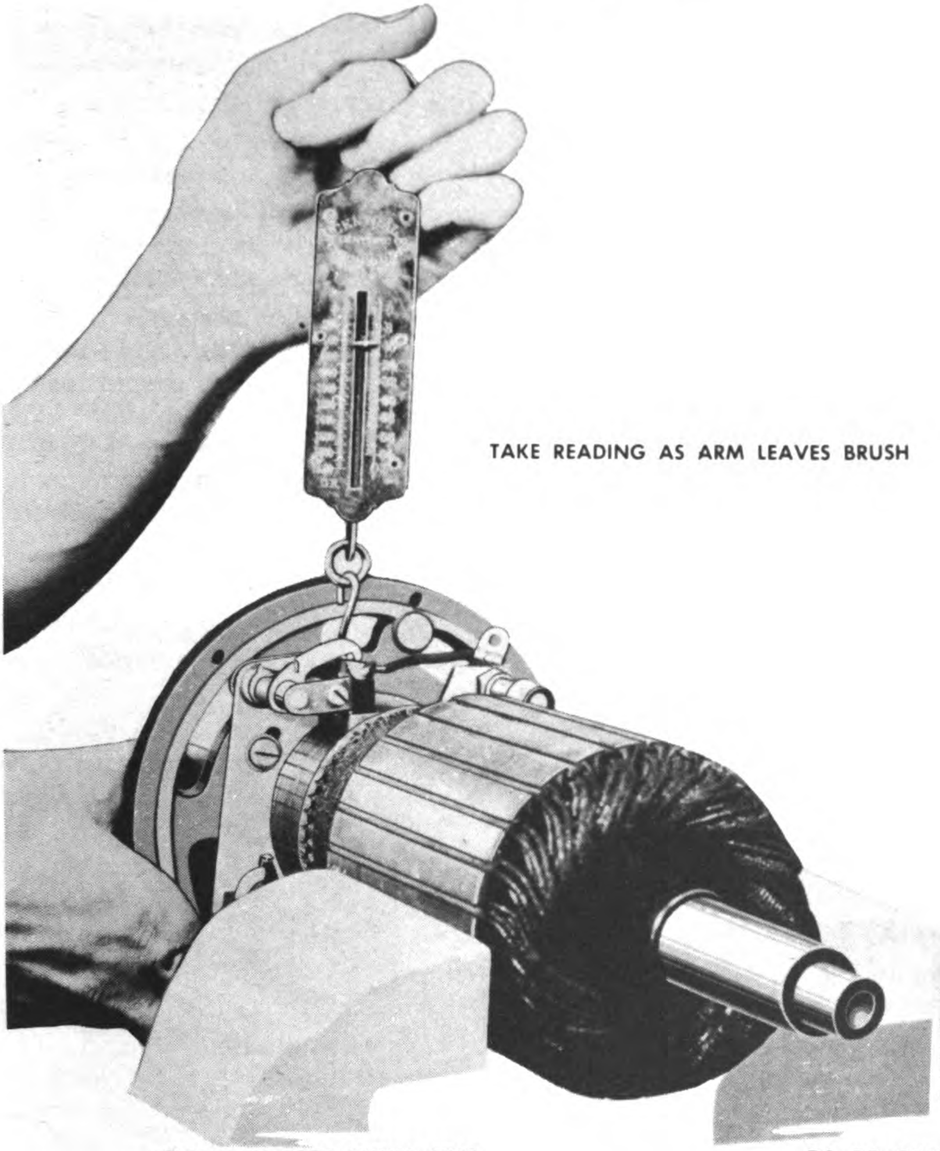

Figure 61—Measuring Brush Spring Tension on GBG-type Generators with Tension Gage (41-G-105)

e. Miscellaneous Parts. Inspect all parts for wear and distortion, and replace any part that cannot be cleaned and straightened to give satisfactory service.

28. REPAIR AND REBUILDING OF COMPONENTS.

a. Frame and Field Assembly.

(1) Replace defective leads, terminals, terminal studs, condensers, and insulation.

(2) If coils test grounded, open or shorted, remove pole shoe screw. Assemble new coil on the pole shoe and install in frame. Dip

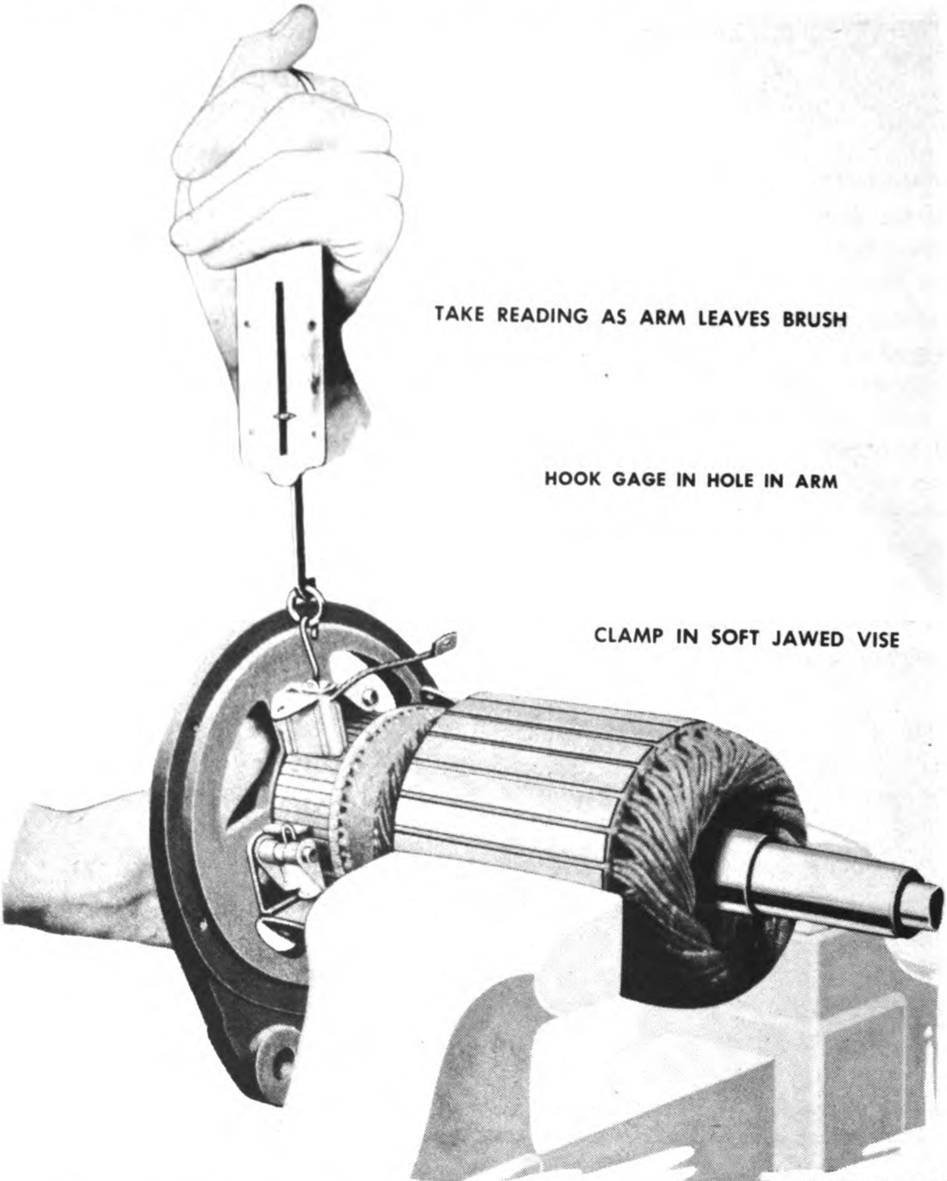

Figure 62—Measuring Brush Spring Tension on GDJ, GFR, and GFZ-type Generators with Tension Gage (41-G-105)

pole shoe screw in boiled linseed oil and tighten securely. As pole shoe screw is tightened, hit frame a few sharp blows with soft hammer to aline pole shoe. Connect and solder field coil leads and terminals. When installing complete set of coils, assemble terminal stud and leads to field coils before installation in frame.

(3) Clinch and solder loose connections and terminals using rosin core solder. Never use acid flux on electrical equipment. Be sure all terminals are properly clinched and soldered to make a strong, low resistance connection.

(4) Install terminal studs in frame using new insulation if old washers and bushings are broken or oil soaked.

(5) Check coils for grounds and opens with test probes (par. 27 **a** (3) and (4)).

b. Armature.

(1) Do not attempt to repair armatures with worn or bent shafts, badly scored core, shorted or open windings, loose windings or if commutator is badly burned and scored.

(2) If commutator is rough or worn or if run-out exceeds 0.0005 inch, place armature in lathe. Mount armature on bearing seats if lathe is so equipped, otherwise mount on shaft centers. Take light cuts (fig. 22) until armature is completely cleaned up then remove all burs with 2/0 flintpaper (fig. 23). Do not use armature if commutator finishes up smaller than 2¾ inches diameter. After turning commutator, undercut mica to a depth of 1/32 to 3/64 inch (fig. 24). Undercut must be square and free from burs (fig. 25). If commutator has been turned, check armature for grounds and shorts (par. 27 **b** (2) and (4)).

c. Commutator End Head.

(1) Replace defective parts and do not attempt to straighten bent parts.

(2) On GBG-type generators disassemble brush holders by removing nut from brush holder stud. Discard complete brush plate if insulation on riveted studs is faulty or if studs are not perpendicular to plate.

(3) On GDJ and GFZ generators brush arms and springs are removed as illustrated in figure 46. Do not attempt to repair brush holders or studs and replace complete head if grounds are present.

(4) If new arms, holders, or springs, have been installed check brush alinement and brush spring tension (par. 27 **c**).

(5) If new brushes are installed, place armature in padded vise and install commutator end head and bearing on shaft. Install brushes in holders. Cut strip of 2/0 flintpaper exact width of commutator. Place this strip under a brush with sanded side toward brush. Hold flintpaper against commutator and pull so that brush is forced toward holder (figs. 47 and 63). Lift brush arm and inspect brush to make sure face is perfectly sanded over entire surface. Sand each brush once or twice as additional sanding merely shortens brush life.

d. Drive End Head. There are no repairs to parts of drive end head other than replacement of defective parts.

e. Miscellaneous Parts.

(1) Straighten cover band so that it will fit closely against frame without cracks. Replace band if badly bent.

(2) Replace screws, washers, and other miscellaneous parts, if not in good condition.

29. ASSEMBLY.

a. Install Drive End Head on Armature.

(1) Place spacer on drive end of armature shaft.

(2) Press armature shaft into drive end head (fig. 27). Be sure spacer fits tightly against shoulder on shaft, and bearing fits tightly against spacer.

b. Install Armature in Frame and Field.

(1) Install armature in frame and field and turn drive end head so that marks made during disassembly are alined. If no marks are present turn head so that oiler enters from side just below center when frame is turned with terminal studs up.

(2) Install but do not tighten drive end head attaching screws and lock washers.

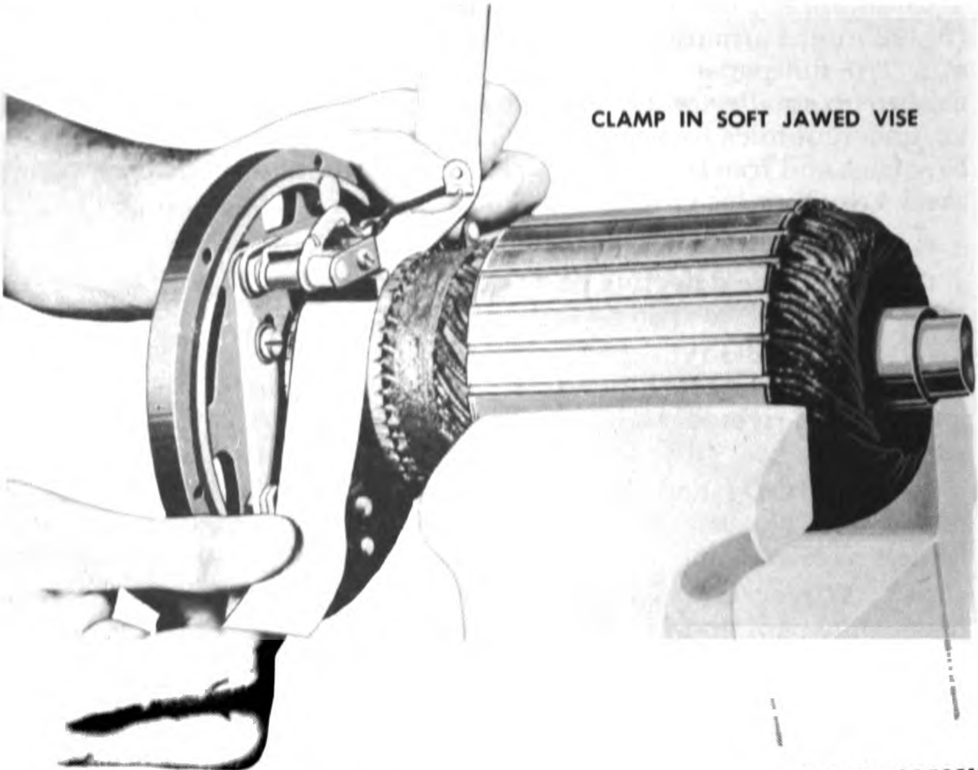

Figure 63—Seating New Generator Brushes with 2/0 Flintpaper—GBG-type Generators

c. Install Commutator End Head on Generator.

(1) Place spacer on commutator end of armature shaft.

(2) Place commutator end head on generator and turn until marks made during disassembly are alined. If no marks are present check grounded and insulated brush position in relation to poles with internal wiring diagram (fig. 64).

(3) Install but do not tighten commutator end head attaching screws and lock washers.

d. Check Mounting and Oiler Alinement. On generators with hinge type mounting, mounting lugs must be alined. Sleeve oilers must

also be alined. If mounting or oilers are not alined, remove drive end attaching screws and turn drive end head. Install drive end screws.

e. Assemble Commutator End Bearing (figs. 51 and 55).

(1) Place spring washer, felt washer retainer, felt washer, second felt washer retainer, and bearing, on armature shaft. Semi-shielded bearings must be assembled with shielded side toward armature. Press parts into bearing bore.

(2) Install bearing retaining washer, screw, and lock washer.

f. Tighten Screws.

(1) Partially tighten commutator end head and drive end head attaching screws.

(2) Strike generator once or twice with soft hammer to aline bearings.

(3) Finish tightening head attaching screws and bearing retaining screw.

g. Install Commutator End Cover (fig. 55).

(1) Place cover and gasket on generator.

(2) Install and tighten attaching screws and lock washers.

h. Install Brushes (figs. 32 and 52). Lift brush arms with hook and place brushes in holders with beveled face turned to fit commutator.

i. Connect Leads.

(1) On GBG-type generators connect brush leads to brush lead screws on their respective holders. Connect leads from armature terminal stud to two insulated brush holders and connect field coil lead to one grounded brush holder.

(2) On GDJ and GFZ generators make same connections, except leads are connected to brush lead screw.

(3) Check internal connections with wiring diagram (fig. 64).

j. Install Fan and Pulley.

(1) Install Woodruff key on shaft.

(2) Place fan on shaft and press into place.

(3) On commutator end fans install shaft plain washer, lock washer and nut and tighten.

(4) On drive end fan and pulley combined, install shaft plain washer, lock washer and nut. Tighten securely. Install cotter pin if used.

(5) On drive end fan only, install lock ring on shaft, then install Woodruff key and drive pulley. Install and tighten shaft plain washer, lock washer, and nut.

k. Install Oil Thrower and Sleeve (GBG 4601 only).

(1) Install oil thrower on shaft and screw into place. Make sure oil thrower does not bind.

(2) Place sleeve on shaft. Center punch sleeve into hole in shaft to hold in place.

30. TESTS AND ADJUSTMENTS.

a. Measure End Play. Mount dial indicator on generator frame or drive end head with plunger in line and resting against end of shaft.

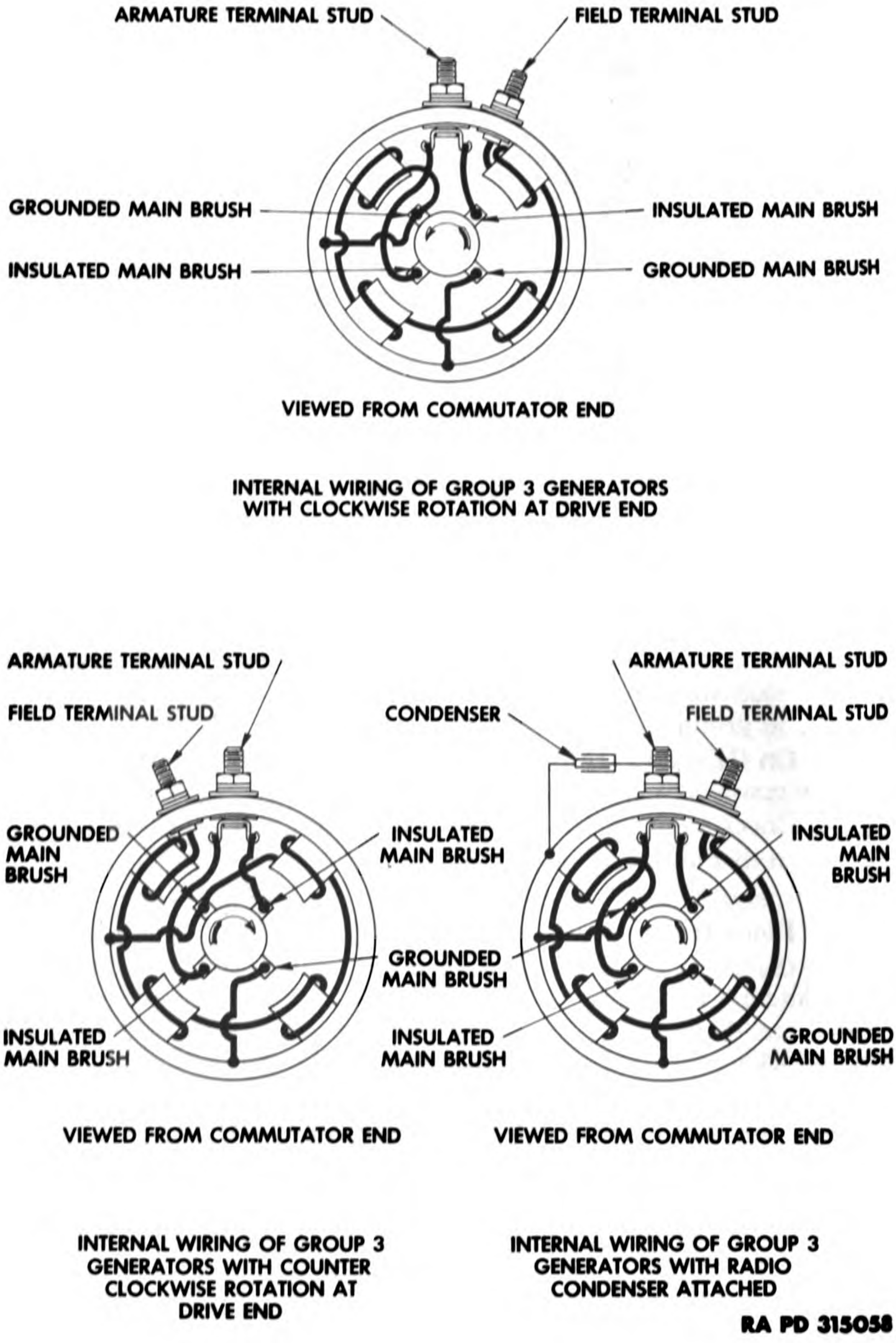

Figure 64—Internal Wiring Diagram of Group 3 Generators

Move armature to its two extreme positions and read indicator (fig. 29). The end play must be 0.003 inch to 0.010 inch. If it is not within these limits it indicates improper generator assembly. Inspect drive end and commutator end bearings for looseness in heads and make sure bearings are down against shaft spacers. Check spacers to make sure they are tight against shoulder on shaft.

b. Set Brush Position (GBG type only).

(1) If brush holder has been set by marks made at disassembly this operation need not be performed. However, if new brush plate or head has been installed or if marks were obliterated, brush position must be adjusted.

(2) Connect battery to test stand for correct polarity and voltage (par. 31 **c**).

(3) Connect battery ground lead to generator frame and connect second battery lead to generator armature terminal. Connect short jumper lead from generator armature to field terminals. See motoring test hookup (fig. 36).

(4) Slightly loosen hexagon head brush plate lock screw.

(5) Close test stand battery switch.

(6) LOCATE NEUTRAL POSITION.

(a) Place screwdriver against brush plate and rotate plate until armature stops turning.

(b) Move plate until by feeling pulley there is no tendency for armature to turn in either direction.

(7) Open battery switch.

(8) Note position of one brush on commutator.

(9) Hold armature from turning and move brush plate against direction of normal armature rotation (par. 31 **d**) until brushes are exactly ⅓ commutator bar advanced from neutral position.

(10) Tighten hexagon-head brush plate locking screw.

c. Electrical Tests and Adjustments (par. 24 **c**).

31. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Poles—4

Brushes—4

Lubrication—Three to five drops of engine oil (SAE 30) in oilers every 100 hours of operation and at assembly. Pack ball bearings ½ full with high temperature grease at assembly.

b. Mechanical.

Rotation—See tabulation (par. 31 **d**).

Brush length (new)

GBG type—1¹⁄₃₂ inch.

GDJ and GFZ types—1 inch.

Brush length (worn) ½ inch minimum.

Commutator diameter (new) 3.00 inches.

Commutator diameter (worn) 2.75 inches minimum. NOTE: *Can be used at smaller diameters if arcing at brushes is not excessive at full output.*

Brush spring tension (with new brushes).
GBG and GCH types—23 to 26 ounces.
GDJ and GFZ types—71 to 76 ounces.

End play—0.003 inch to 0.010 inch.

Commutator run-out (total reading) 0.0005 inch maximum.

Commutator mica undercut—1/32 inch to 3/64 inch.

Shaft diameter (new shaft).
Commutator end—0.9838 to 0.9840 inch.
Drive end—0.9840 to 0.9842 inch.

Bearing diameter (new bearing)
Commutator end—0.9839 to 0.9843 inch.
Drive end—0.9839 to 0.9843 inch.

c. **Electrical.**

Rated volts—See tabulation (par. 31 **d**).

Ground polarity—See tabulation (par. 31 **d**).

Control—Vibrating type current-voltage regulator.

Field fuse—None.

Condenser—GDJ 4812A only—Capacity 0.9 to 1.1 microfarads.

Internal wiring—Figure 64.

Test hookups—Figure 36.

Field coil draw (complete set of coils).
GBG type—1.4 to 1.5 amperes at 13.0 volts.
GDJ type—1.5 to 1.7 amperes at 13.0 volts.
GFZ type—0.9 to 1.0 amperes at 26.0 volts.

Motorizing draw
GBG type—4.0 to 4.4 amperes at 13.0 volts.
GDJ type—7.6 to 8.4 amperes at 13.0 volts.
GFZ type—2.9 to 3.2 amperes at 26.0 volts.

Output
GBG type*—15.0 volts, 40.0 amperes, 1,150 maximum revolutions per minute.
GDJ type*—15.0 volts, 55.0 amperes, 1,200 maximum revolutions per minute.
GFZ type*—30.0 volts, 25.0 amperes, 950 maximum revolutions per minute.

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* Do not operate at this output without ventilating fan and do not operate at higher outputs as it will overheat generator and may burn armature and fields.

GENERATORS—GROUP 3

d. Tabulated Specifications.

Generator	Volts	Rotation	Ground Polarity	Regulator Used With
GBG 4601	12	CW	Pos	VRA 4102A
GBG 4612	12	CCW	Neg	VRA 4105A
GDJ 4802A	12	CW	Neg	VRH 4102A
GDJ 4804	12	CW	Neg	VRH 4104A-1
GDJ 4804A	12	CW	Neg	VRH 4104A-1
GDJ 4804B	12	CW	Neg	VRH 4104B-1
GDJ 4804C	12	CW	Neg	VRH 4104B-1
GDJ 4808	12	CW	Neg	VRH 4104A-1
GDJ 4808A	12	CW	Neg	VRH 4104A-1
GDJ 4809A	12	CW	Neg	VRH 4102A
GDJ 4809B	12	CW	Neg	VRH 4102A
GDJ 4812A	12	CW	Neg	VRH 4106A
GDJ 4819A	12	CW	Neg	VRH 4102A
GDJ 4820A	12	CW	Neg	VRH 4104C-1
GFZ 4801A	24	CW	Neg	VAL 4101A
GFZ 4801B	24	CW	Neg	VAL 4101A

CW—Clockwise rotation at drive end.
CCW—Counterclockwise rotation at drive end.
Neg—Negative ground.
Pos—Positive ground.

CHAPTER 2

GENERATORS (Cont'd)

Section V

GENERATORS—GROUP 4

32. DESCRIPTION AND DATA.

a. Description.

(1) Group 4 generators are four pole, four-brush units with the output controlled by a separately mounted current and voltage regulator. Figure 65 is a disassembled view of a typical Group 4 generator showing the main components and their attaching parts.

(2) These generators have no internal regulation incorporated in their design and must be used with a regulator designed to operate with this type of generator.

(3) For model numbers of Group 4 generators, see paragraph 1.

b. Data.

Rated volts—24.

Rotation—Counterclockwise at the drive end.

Ground polarity (negative).

Field coil draw—0.93 to 1.02 amperes at 26.0 volts.

Motorizing draw—5.18 to 5.7 amperes at 26.0 volts.

Output—30.0 volts, 50.0 amperes, 1,725 maximum revolutions per minute.*

33. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Remove terminal shield cover and heat shield, if used.

(2) Wipe outside of generator with cloth dampened in dry-cleaning solvent. Make sure terminals and pulley are clean. Do not allow dry-cleaning solvent to enter generator.

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*Do not operate at this output without ventilating fan and do not operate at larger outputs as it will overheat the generator and burn armature and fields.

b. Inspecting.

(1) Inspect frame, end heads, and fan, for wear and cracks. If any part is cracked disassemble generator and install new part (pars. 34 and 38). If drive pulley is cracked or broken or if belt surface is rough install new pulley (par. 34). If any fan blade is broken or cracked install new fan.

(2) Take out clamp screw and lift cover band from generator.

(3) Lift brush arms with hook and take brushes out of their holders (fig. 32). Blow off brush holders and commutator with clean dry compressed air. If brush holders are dirty, gummy, or corroded, disassemble and overhaul generator (pars. 34 to 40). Install new brushes if they are oil soaked or are worn to less than ½ inch in length. To install new brushes disconnect brush lead from holder (fig. 66). Install new brushes in holders so that beveled face fits commutator. Connect brush leads to holders. Connect field coil, terminal post, and condenser leads, to the brush holders at the same time. Connect the two leads from armature terminal post to the two insulated brush holders. Connect lead from field coil to one grounded brush holder. Generators GFR 4804A, GFR 4804B and GFR 4804C have two condensers mounted in frame. Connect leads from these condensers to insulated brush holders. Hold brush arm with hook and try fit of brushes in holders. Brushes must slide freely without sticking. If brushes do not slide freely, disassemble generator and clean thoroughly (pars. 34 to 40). Inspect alinement of brushes on commutator. If edges of brushes are not in perfect alinement with commutator segments, disassemble generator and install new head (par. 34).

(4) Inspect commutator. If commutator is rough or worn, disassemble generator and turn down commutator (par. 37 **b**). If commutator is only dirty or discolored, clean by holding 2/0 flintpaper against it while turning armature slowly. Blow sand out of generator with clean dry compressed air.

(5) If new brushes are installed cut strip of 2/0 flintpaper the exact width of commutator. Place this strip under a brush with sanded side toward brush. Hold flintpaper to fit contour of commutator without rounding edges of brush. Pull so that brush is forced toward brush holder (fig. 34). Once or twice is sufficient sanding for each brush as additional sanding merely shortens brush life.

c. Testing.

(1) MEASURE FIELD COIL DRAW (fig. 36).

(a) Mount generator on test stand.

(b) Use fully charged 24-volt battery and connect voltmeter lead and one test stand battery lead to generator field terminal stud. Connect remaining battery and voltmeter leads to generator frame.

(c) Close test stand battery switch, adjust rheostat until voltage is 26.0 volts, and read ammeter. If current is not between 0.93 and 1.02 amperes, overhaul generator and look for faulty field coils or connections (par. 36).

(d) Open test stand battery switch.

(e) Disconnect leads from generator.

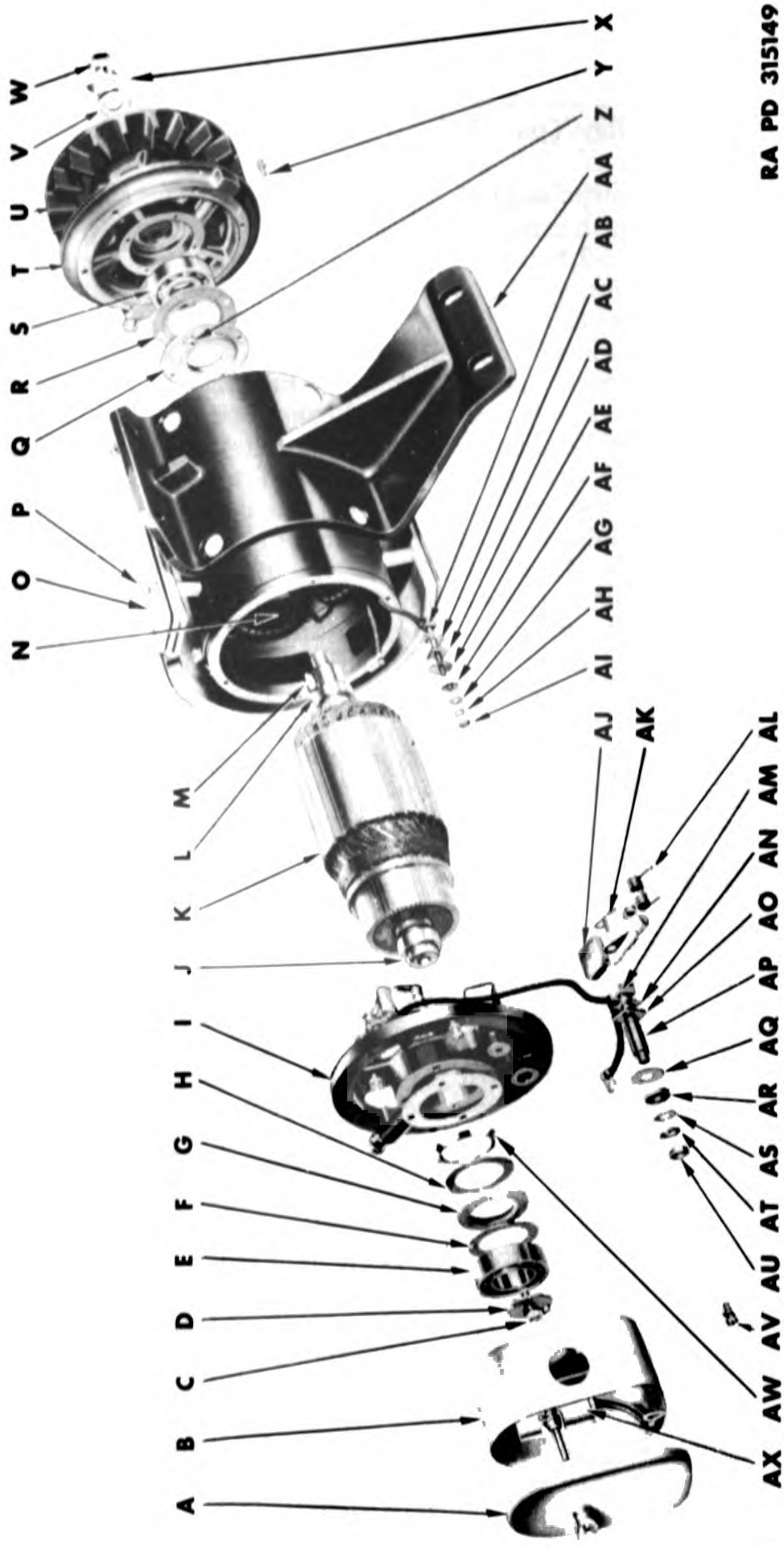

Figure 65—Main Components of Group 4 Generators

GENERATORS—GROUP 4

(2) MEASURE MOTORIZING DRAW (fig. 36).

(a) Connect battery to test stand for negative ground polarity.

(b) Connect battery ground lead to generator frame and connect other battery lead to generator armature terminal. Connect voltmeter from generator frame to generator armature terminal. Connect jumper lead from field terminal to armature terminal.

(c) Close test stand battery switch. The generator must operate as a motor with armature turning slowly.

A—COVER
B—SHIELD
C—SHAFT SCREW
D—BEARING RETAINING WASHER
E—BALL BEARING
F—FELT RETAINING WASHER
G—FELT WASHER
H—FELT RETAINING WASHER
I—COMMUTATOR END HEAD
J—SHAFT SPACER
K—ARMATURE
L—SHAFT SPACER
M—WOODRUFF KEY
N—FRAME AND FIELD ASSEMBLY
O—HEAT SHIELD
P—SHIELD ATTACHING SCREW
Q—BEARING RETAINER
R—GASKET
S—BALL BEARING
T—DRIVE END HEAD
U—DRIVE PULLEY AND FAN
V—SHAFT PLAIN WASHER
W—SHAFT NUT
X—SHAFT LOCK WASHER
Y—HEAD ATTACHING SCREW
Z—RETAINER ATTACHING SCREW
AA—MOUNTING BRACKET
AB—FIELD TERMINAL STUD
AC—CLAMP
AD—INSULATION
AE—INSULATING WASHER
AF—INSULATING WASHER
AG—PLAIN WASHER
AH—LOCK WASHER
AI—NUT
AJ—BRUSH
AK—BRUSH ARM
AL—BRUSH SPRING
AM—ARMATURE TERMINAL STUD
AN—CLAMP
AO—INSULATION
AP—INSULATING BUSHING
AQ—INSULATING WASHER
AR—INSULATING WASHER
AS—PLAIN WASHER
AT—LOCK WASHER
AU—NUT
AV—SHIELD ATTACHING SCREW
AW—SPRING WASHER
AX—CONDENSER

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Legend for Figure 65—Main Components of Group 4 Generators

(d) Adjust voltage to 26.0 volts and read ammeter. If the current is not between 5.18 and 5.70 amperes it indicates worn bearings, incorrect bearing alinement, shorts, or improper generator assembly. Overhaul generator and look for above conditions if motorizing draw is incorrect or if armature does not turn.

(e) Open test stand battery switch.

(3) CHECK GENERATOR OUTPUT (fig. 36).

(a) With generator connected as above for motorizing, test connect armature shaft to test stand motor with coupling.

(b) Close test stand battery switch.

(c) Start test stand motor so that generator is driven counterclockwise at drive end.

(d) Increase speed slowly, keeping voltage at 30.0 volts by adjusting load rheostat across battery. It is important that voltage be held at 30.0 volts.

(e) Note ammeter reading as speed is increased. When current output reaches 50.0 amperes, read tachometer. Speed should not be more than 1,725 revolutions per minute. Do not operate in this manner for more than three minutes without ventilating fan and do not operate at larger voltages and current, as there is danger of burning armature and fields. If output cannot be obtained or if speed is too high, overhaul generator and inspect for high resistance connections, dirty commutator, worn or oil soaked brushes, poor brush contact, or

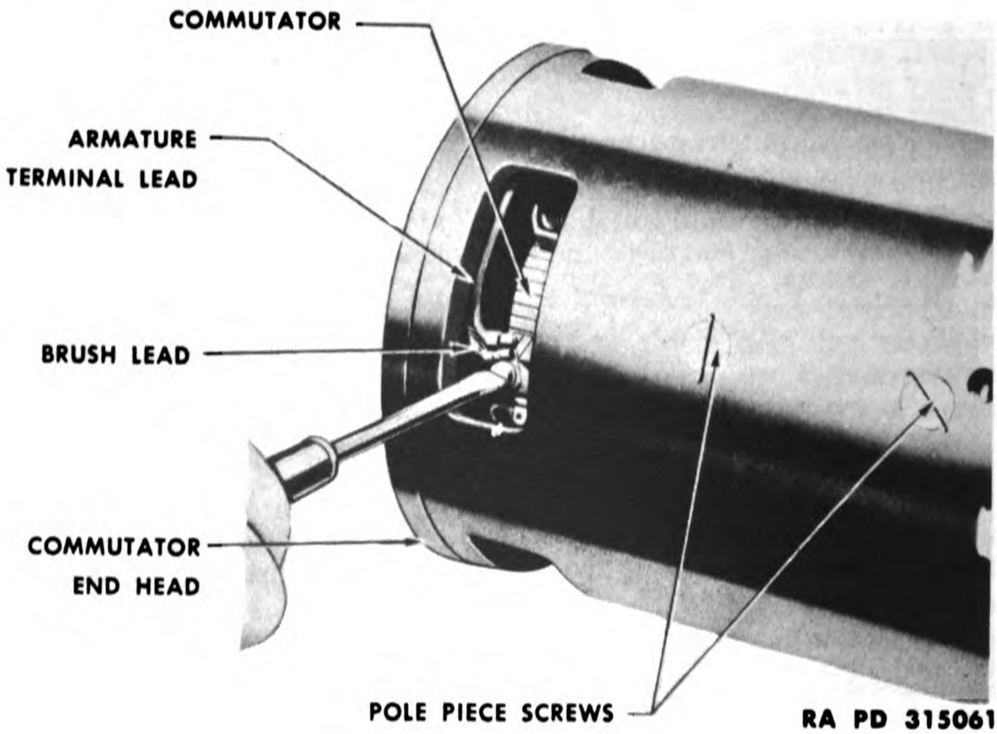


Figure 66—Disconnecting Brush Lead from Holder—Group 4 Generators

improper brush plate assembly (pars. 34 to 40). Faulty coils or armatures also cause incorrect readings.

34. DISASSEMBLY.

a. Remove Terminal Shield Cover. Unscrew wing nut and lift cover off.

b. Remove Heat Shield (GFR 4801, A, B, GFR 4802, A, B). Take out six screws and lift shield from generator.

c. Remove Drive Pulley.

(1) Remove cotter pin (GFR 4803, A, B, GFR 4804A, B, C).

(2) Unclinch lock washer on shaft nut (GFR 4801, A, B, GFR 4802, A, B).

(3) Remove shaft nut and lock washer.

(4) Pull pulley from shaft.

(5) Remove Woodruff key from shaft. (GFR 4801, A, B, GFR 4802, A, B).

d. Remove Brushes.

(1) Take out brush lead screws (fig. 66).

(2) Lift brush arm with hook and pull brushes from holders (fig. 32).

e. Remove Condenser (GFR 4801, A, B, GFR 4802, A, B, GFR 4803, A, B) (fig. 67).

(1) Take nut from armature terminal stud and slip condenser lead from stud.

(2) Remove nut from condenser mounting stud and lift off condenser and insulating tube.

f. Remove Terminal Shield (fig. 67). Take out screws holding shield to commutator end head and lift off shield.

g. Remove Field Terminal Post Nuts and Washers (fig. 67). Take off nuts and washers from field terminal stud.

h. Remove Commutator End Cover (fig. 67). Take out screws holding cover to head and lift off cover and gasket.

i. Remove Bearing Retainer. Take out the shaft screw and bearing retainer.

j. Remove Commutator End Head (fig. 67).

(1) With straightedge and sharp point, mark relationship of head to frame.

(2) Take out six head-attaching screws.

(3) Press field terminal stud out of head.

(4) Tap head lightly with soft hammer to loosen from frame and pull head from generator.

(5) On GFR 4801, A, B and GFR 4802, A, B, bearing will remain in head. Press bearing out with fingers.

(6) On GFR 4803, A, B and GFR 4804A, B, C, bearing will remain on armature shaft. Remove bearing with bearing puller.

(7) Remove insulating bushing and washers from field terminal stud.

k. Remove Drive End Head and Armature.

(1) With straightedge and sharp point, mark relationship of head to frame.

(2) Take out six head attaching screws.

(3) Pull head and armature from frame and field.

(4) Press armature shaft out of head (fig. 11).

(5) Remove spacer from shaft.

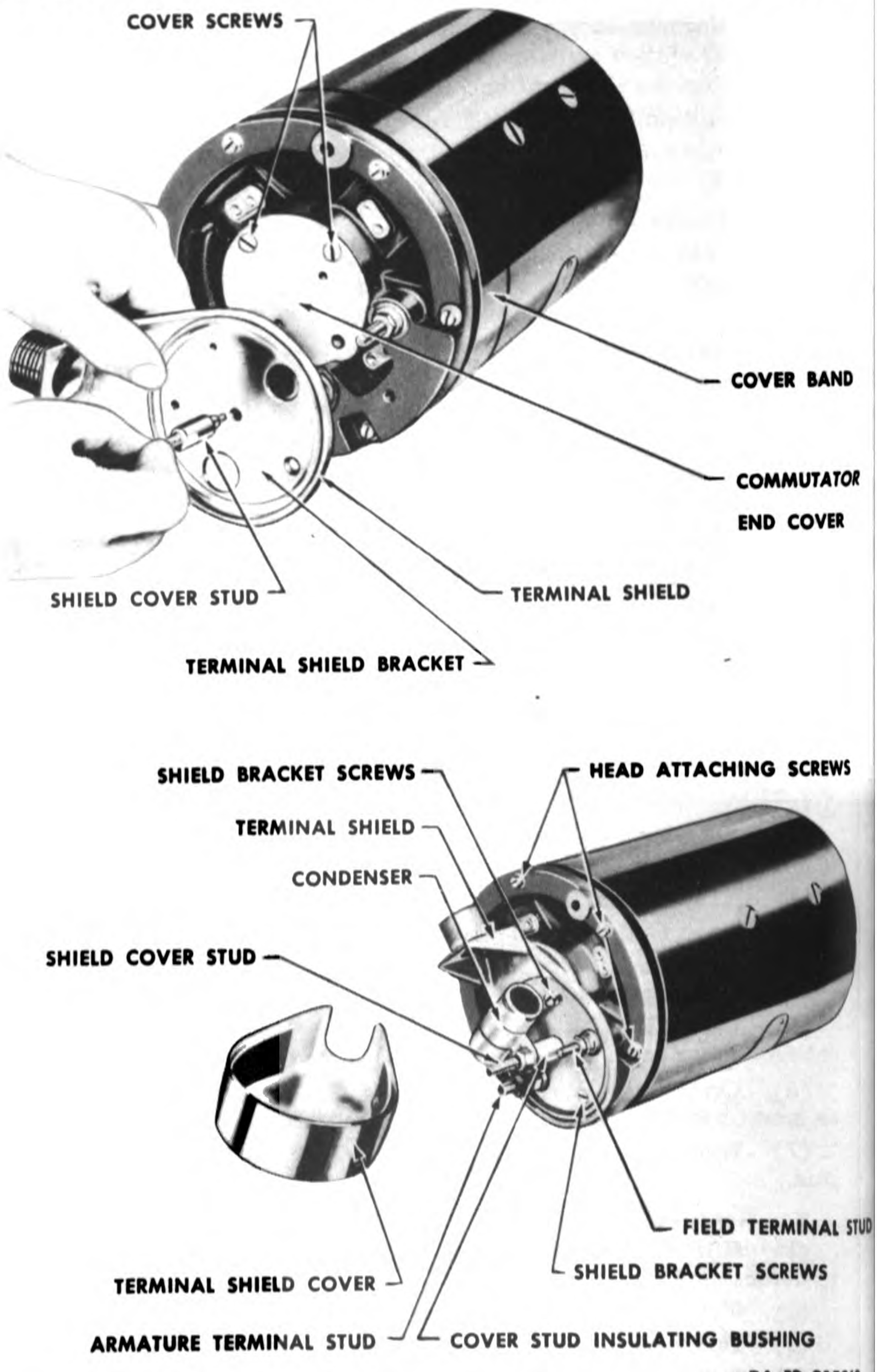


Figure 67—Commutator End Construction of Group 4 Generators

35. CLEANING OF COMPONENTS.

a. Frame and Field Assembly. Clean frame and field assembly with cloth dampened in dry-cleaning solvent. Do not soak in dry-cleaning solvent and be careful not to damage insulation or leads. Dry with clean dry compressed air.

b. Armature. Blow all loose dirt off with compressed air. Wipe armature with clean cloth dampened in non-oily dry-cleaning solvent. Sand commutator with 2/0 flintpaper. Do not handle commutator. Clean dirt from between commutator bars but do not damage or form burs on bars or mica.

c. Commutator End Head.

(1) On GFR 4801, A, B and GFR 4802, A, B unscrew oiler from side of head. Clean oiler thoroughly in dry-cleaning solvent.

(2) Remove nuts and washers from armature terminal stud and press stud out of head.

(3) Soak head and brush holders in dry-cleaning solvent and clean with soft rag. Dry with compressed air and remove all lint.

(4) Wipe brushes with clean dry rag.

(5) Wipe fully shielded and sealed bearings used on GFR 4803, A, B and GFR 4804A, B, C clean with rag dampened in dry-cleaning solvent. Do not soak as these bearings cannot be repacked with grease. Soak semi-shielded bearings used on GFR 4801, A, B and GFR 4802A, B in dry-cleaning solvent and clean thoroughly. Dry with clean compressed air but do not spin.

(6) Wipe felt washers clean with rag.

(7) Wipe condensers used on GFR 4801, A, B, GFR 4802, A, B and GFR 4803, A, B clean with rag dampened in dry-cleaning solvent.

(8) Clean armature terminal stud and lead thoroughly in dry-cleaning solvent.

(9) Clean insulating washers and bushings in dry-cleaning solvent but do not soak.

(10) Clean retainers, covers, screws, and gaskets, in dry-cleaning solvent.

d. Drive End Head.

(1) Take out bearing retainer screws and remove retainers, felt washers, and bearing. Press felt washer and felt retainer out of bearing retainer. Remove oiler and felt wick, if used.

(2) Soak head, oiler, gaskets, and retainers, in dry-cleaning solvent and clean with soft rag. Dry with compressed air. Remove all lint.

(3) Wipe fully shielded or sealed bearings clean with rag dampened in dry-cleaning solvent. Do not soak as these bearings cannot be repacked with grease. Soak semi-shielded and plain ball bearings in dry-cleaning solvent and clean thoroughly. Dry with clean compressed air but do not spin.

(4) Wipe felt washers and wicks clean with rag.

e. Miscellaneous Parts. Clean balance of parts in dry-cleaning solvent and dry thoroughly.

36. INSPECTION AND TEST OF COMPONENTS.

a. Frame and Field.

(1) Inspect frame and field for worn or frayed insulation, broken leads and loose or corroded terminals. Repair or replace defective parts (par. 37 **a**).

(2) Check field coils for grounds with test probes consisting of a lamp in series with two points and a source of electricity (fig. 12). Make sure no leads are touching frame and touch one test probe to a ground on frame. Touch second probe to field terminal stud (fig. 68). If lamp lights, a coil is grounded.

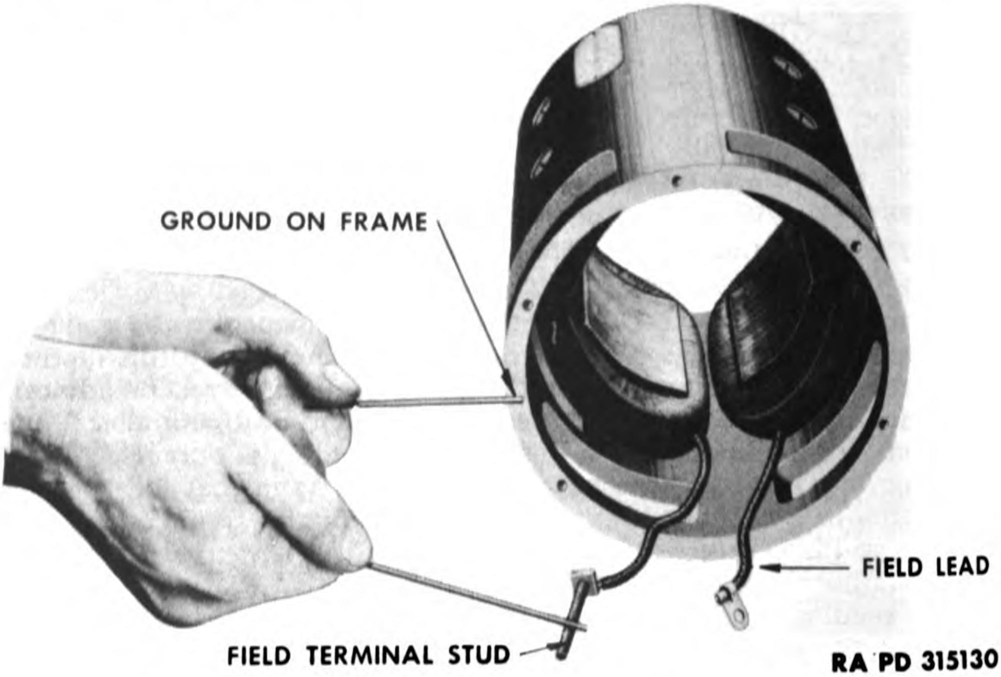


Figure 68—Testing Field Coils for Grounds with Test Probes—Group 4 Generators

(3) Touch one test probe to field terminal stud and touch second probe a field coil ground lead (fig. 69). If lamp does not light, a coil has an open circuit.

(4) If coils do not test grounded or open, measure current draw. Connect ammeter, battery, and variable resistance, in series with two field coil leads. Connect voltmeter to two leads. Adjust voltage to 26.0 volts and read ammeter. If current is not between 0.93 and 1.02 amperes it indicates shorted field coils.

(5) If field coils are grounded, open or shorted, replace complete frame and field assembly. However, in case of necessity new coils can be installed (par. 37 **a**).

(6) Check condensers on GFR 4804A, B, C for grounds from condenser terminal to generator frame. It is not necessary to remove condensers from frame. Measure capacity from terminal to generator

frame. If condenser is grounded or if capacity is not between 0.21 to 0.25 microfarads, remove condenser from frame and check again. Install new condensers if second check shows them to be at fault. Install condensers in frame making sure cases are properly grounded to frame.

b. Armature.

(1) Inspect armature to make sure all coils are properly pressed into core slots and all are soldered to commutator risers. Replace armature if coils are loose or unsoldered. Inspect core for wear and discard armature if scored badly. If commutator is rough or worn turn down (par. 37 **b**). Inspect shaft bearing seats for wear and discard armature if wear is evident.

(2) Touch one test probe to core or shaft and touch other probe to each commutator segment in turn (fig. 17). If ground is present lamp will light. Do not touch probes to bearing or brush surfaces as an arc would mar the smooth finish. Replace armature if grounded.

(3) Touch test probes to each pair of adjacent commutator bars (fig. 43). Do not touch test probes to brush surface. If lamp does not light it indicates an open. Repeat this test on every pair of adjacent bars and replace armature if any coil is open.

(4) Check armature for shorts. Do not use usual growler and steel strip test as all Group 4 armatures will test shorted by this method. Mount armature on growler and adjust two contacts to rest on adjacent commutator bars. Connect these contacts to an a-c milliammeter. Move contacts around commutator until highest reading is obtained. When position of contacts is determined keep contacts in that location and turn armature to bring each pair of segments under contacts (fig. 58). Take a milliammeter reading for each pair of adjacent bars. Readings must be nearly uniform for all readings. If a coil is shorted milliammeter reading will drop to almost zero. Replace armature if shorted.

(5) Place armature with bearing seats on "V" blocks and place dial indicator with plunger against commutator. Rotate armature and measure total indicator reading (fig. 19). If total out of round is larger than 0.0005 inch turn down commutator (par. 37 **b**).

(6) If commutator has been turned, test armature for grounds and shorts (par. 36 **b** (2) and (4) above).

c. Commutator End Head.

(1) Inspect head and parts for cracks and distortion and discard if defective. Discard felt washers and wicks if torn or gritty. Discard gasket if not in perfect condition. Discard brushes if cracked, oil soaked, worn to less than ½ inch in length, or if brush leads and terminals are frayed, broken, or corroded.

(2) Inspect armature terminal stud for corrosion, stripped threads, improper soldering, and for broken or frayed leads. Repair or replace if these conditions are found. Install new insulating washers and bushing if cracked or oil soaked. Assemble terminal stud and insulation in head.

(3) Touch one test probe to a ground on head and touch other probe to insulated brush holders. If a brush holder is grounded, discard head. Make sure leads are not touching head and touch terminal stud

and head with test probes. If lamp lights it indicates a grounded terminal stud. Install new terminal stud insulation and check for correct assembly of stud and insulation.

(4) Place armature in padded vise, and install commutator end head and bearing on shaft. Press bearing into head. Feel side play of head. If any side movement can be felt it indicates a worn bearing, worn shaft, or loose bearing fit in head. Inspect to find cause of side play and discard worn or faulty part.

(5) With head and bearing on armature, install brushes in holders.

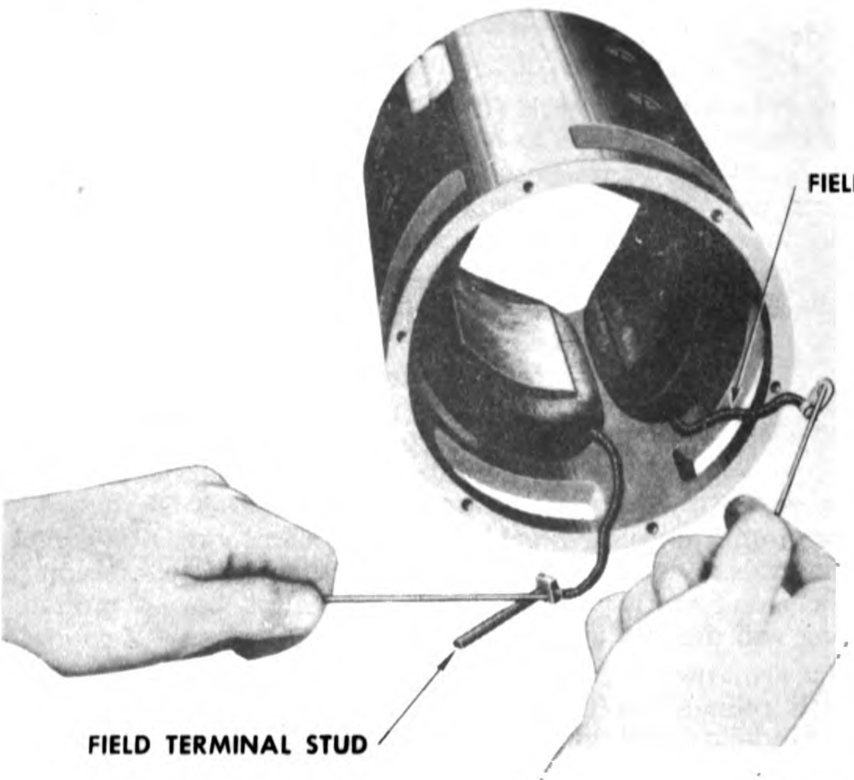


Figure 69—Testing Field Coils for Open Circuits with Test Probes—Group 4 Generators

Make sure beveled face fits commutator. Discard head if brushes do not slide freely or if edges of brushes are not in perfect alinement with commutator segments.

(6) Hook spring scale in hole in end of brush arm. Pull scale on line parallel to face of brush and take reading just as arm leaves brush (fig. 62). Adjust tension for all brushes to 71 to 76 ounces by removing brush arm and spring (fig. 46) and bending spring.

(7) Pack plain and semi-shielded ball bearings ½ full with a high temperature grease and soak felt washers and wicks in engine oil (SAE 30). Keep oil from brushes or holders and drain off excess oil.

(8) Inspect condenser used on GFR 4801, A, B, GFR 4802, A, B and GFR 4803, A, B for broken or frayed lead, loose terminal, and loose or broken bracket. Discard condenser if these conditions are found. Check condenser for grounds and capacity. Replace if grounded or if capacity is not between 0.9 and 1.1 microfarads.

d. Drive End Head.

(1) Inspect head for cracks and inspect retainers for distortion. Replace if defective. Replace bearing if worn or damaged or if seal type bearing lacks lubricant. Discard felt washers and wicks if torn, ragged, or gritty.

(2) Install bearing in head. It must fit easily without looseness or binding. Discard head if bearing is loose.

(3) Pack semi-shielded and plain ball bearings half full with high temperature grease and soak felts in engine oil (SAE 30). Drain off excess oil.

(4) Install bearing, retainers, and washers, in head and tighten holding screws and lock washers. Semi-shielded bearings must be installed with shielded side toward armature. Make sure retainers are tight against head.

e. Miscellaneous Parts. Inspect all parts for wear and distortion, and discard any part that cannot be cleaned and straightened to give satisfactory service.

37. REPAIR AND REBUILDING OF COMPONENTS.

a. Frame and Field.

(1) Replace defective leads, terminals, and terminal studs. When soldering use rosin core solder and make a good, clean, low resistance connection.

(2) Replace defective condensers on GFR 4804A, B, C generators. Make sure condenser bracket and frame are clean and free of paint. Tighten mounting screws and stake frame into screw slot to prevent turning.

(3) It is recommended that complete frame and field assembly be discarded if coils are grounded, shorted, or open. For temporary repair new coils can be installed as follows:

(a) Remove pole shoe screws.

(b) Remove lead clamp and condensers on GFR 4804A, B, C.

(c) Mark position of field coils, pole shoes, and leads, and pry field coils out of frame. Discard all coils.

(d) Soak new field coil set in air-drying varnish for at least 10 minutes or until bubbles stop coming to surface. Keep varnish off terminal stud lead and field coil ground lead.

(e) Install coils on pole pieces and assemble in frame. Be sure coils and leads are in proper relation to frame and bracket so that correct relation to commutator end head and brushes can be maintained.

(f) Dip pole shoe screws in boiled linseed oil and assemble in the frame. Tighten securely, then stake frame into screw slots. As screws are tightened, strike frame a few sharp blows with soft hammer to aline pole shoes.

(g) Clean excess varnish from head pilots and condenser mounting seats.

(h) Allow assembly to dry thoroughly, then check for ground, opens, and shorts (par. 36 **a**).

b. Armature.

(1) Do not attempt to repair armatures with worn or bent shafts, badly scored core, shorted or open windings, or badly burned and scored commutator.

(2) If commutator is rough or worn, or if run-out exceeds 0.0005 inch place armature in lathe. Mount armature on bearing seats if lathe is so equipped, otherwise mount on shaft centers. Take light cuts (fig. 22), until armature is completely cleaned up, then remove all burs with 2/0 flintpaper (fig. 23). Do not use armature if commutator finishes up smaller than 2.75 inches in diameter. After turning commutator, undercut mica to a depth of $\frac{1}{32}$ to $\frac{3}{64}$ inch (fig. 24). Cut must be square and free from burs (fig. 25). If commutator has been turned, test for grounds and shorts (par. 36 **b**).

(3) Give windings a coat of air-drying varnish and allow to dry thoroughly. Keep varnish off shaft and commutator.

c. Commutator End Head.

(1) Install new brush arms, springs, terminal post, leads, washers, bushings, and gaskets, if these parts are not in good condition. Discard complete end head if brush holders are bent, distorted or improperly insulated.

(2) If new brushes have been installed cut strip of 2/0 flintpaper the exact width of commutator. Mount armature in padded vise and install commutator end head and bearing on armature shaft. Press bearing into head. Install brushes in holders making sure they are turned so beveled face fits commutator. Place flintpaper under a brush with sanded side toward brush. Hold flintpaper to fit commutator without rounding edges of brush. Pull flintpaper so brush is forced against brush holder (fig. 47). Do not sand excessively as it merely shortens brush life. Once or twice is sufficient. Repeat this sanding on all four brushes. Remove brushes from holders, then remove commutator end head from armature.

d. Drive End Head. There are no repairs to drive end head other than to replace defective parts.

e. Miscellaneous Parts.

(1) Straighten cover band so that it will fit closely against frame without cracks. Replace band if badly bent.

(2) Replace screws, washers, and miscellaneous parts, if not in good condition.

38. ASSEMBLY.

a. Assemble Drive End Head on Armature.

(1) Install spacer on shaft.

(2) Press armature into drive end head (fig. 27). Make sure bearing fits down tight against collar or spacer.

b. Install Armature in Frame and Field.

(1) Place armature in frame.

(2) Turn drive end head to aline marks made at disassembly or, if marks are obliterated, so that oiler will be at side of generator and just below center.

(3) Install but do not tighten drive end attaching screws.

c. Install Commutator End Head.

(1) Place terminal post inner insulation on field terminal post.

(2) Place commutator end head on generator and install field terminal post through hole in head.

(3) Turn head so marks made during disassembly are alined. Install attaching screws and lock washers. Do not tighten screws. If new head is installed or if marks were obliterated check grounded and insulated brush position in relation to poles with internal wiring diagram (fig. 70).

d. Install Commutator End Bearing.

(1) On GFR 4803, A, B and GFR 4804A, B, C install bearing on shaft with sealed side toward generator. Press bearing into head.

(2) On GFR 4801, A, B and GFR 4802, A, B assemble shaft spacer, spring washer, felt retainer, felt washer, second felt retainer, and bearing, on shaft. Make sure bearing is turned so shielded side is toward generator. Press bearing into head.

(3) Install bearing retainer, shaft screw, and lock washer, on shaft.

e. Tighten Head Screws.

(1) Tighten end head attaching screws, tightening both heads gradually. Strike frame one or two sharp blows with soft hammer as screws are tightened.

(2) Tighten commutator end bearing retaining screw.

(3) Stake drive end head into screw slots.

(4) Lock wire commutator end head attaching screws and bearing retaining screw.

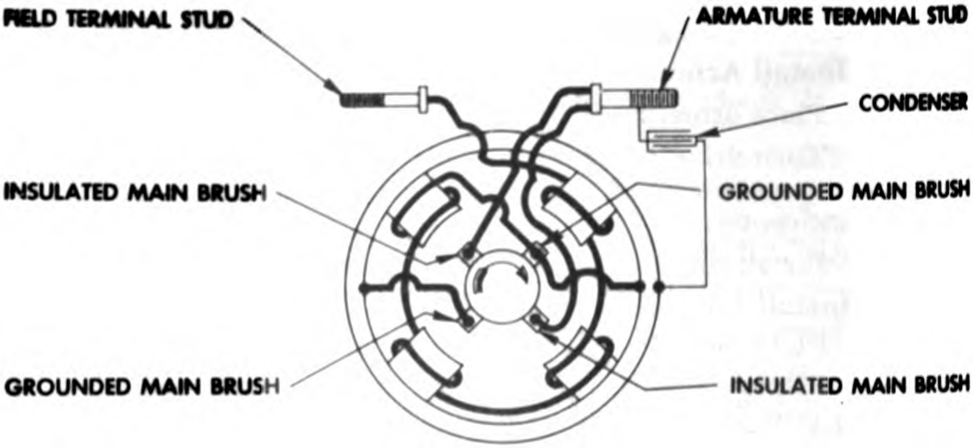
f. Assemble Field Terminal Stud.

(1) Install insulating bushing, insulating washers, plain washer, lock washer, and nuts, on stud and tighten.

(2) Make sure field coil ground lead is not touching ground, then touch test probes to field terminal stud and to ground on head. If ground is present install new terminal post insulation.

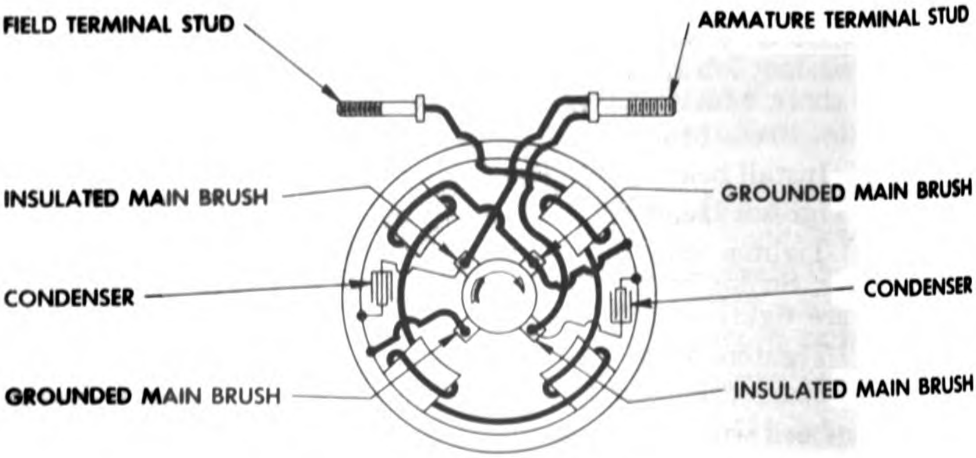
g. Install Commutator End Cover and Shield (fig. 67).

(1) On GFR 4801, A, B and GFR 4802, A, B assemble gasket and shield on generator. Install screws and lock washers and lock wire.



VIEWED FROM COMMUTATOR END

INTERNAL WIRING OF GFR-4801,A,B, GFR-4802,A,B and GFR-4803,A,B GENERATORS



VIEWED FROM COMMUTATOR END

INTERNAL WIRING OF GFR-4804,A,B GENERATORS

RA PD 315059

Figure 70—Internal Wiring Diagrams of Group 4 Generators

(2) On GFR 4803, A, B and GFR 4804A, B, C assemble gasket and cover on generator and install one flathead screw. Assemble shield and plate on generator and install cover stud and three more flathead screws. Be sure toothed lock washer is on stud. Tighten four screws and stake plate into screw slots.

h. Install Condenser (GFR 4801, A, B, GFR 4802, A, B and GFR 4803A, B) (fig. 67).

(1) Place insulating sleeve on stud and assemble plain washers, condenser bracket, lock washer and nut on stud.

(2) Install condenser lead terminal on armature terminal stud and install lock washer and nut.

i. Install Brushes.

(1) Install brushes in holders (fig. 32). Be sure brushes are turned so beveled face fits commutator.

(2) Connect brush leads to holders (fig. 66). At same time connect armature terminal stud leads to the two insulated brushes and connect field coil ground lead to one grounded brush holder. On GFR 4804A, B, C also connect condenser leads to insulated brush holders. Check internal connections with wiring diagram (fig. 70).

(3) Lock wire brush lead screws.

j. Install Drive Pulley.

(1) Install Woodruff key in shaft on GFR 4801, A, B and GFR 4802, A, B.

(2) Install pulley on shaft.

(3) Install and tighten shaft lock washer and nut.

(4) On GFR 4801, A, B and GFR 4802, A, B bend ears of lock washer against sides of nut.

(5) On GFR 4803, A, B and GFR 4804A, B, C install and spread cotter pin.

k. Install Cover Band. Install cover band around generator so all inspection holes are covered. Tighten and lock wire clamp screw.

l. Install Heat Shield.

(1) Install heat shield, spacers and screws.

(2) Tighten and lock wire screws.

m. Install Terminal Shield Cover. Install shield cover on generator. Do not lock wire as it must be removed to connect generator on bench or engine.

39. TESTS AND ADJUSTMENTS.

a. Measure End Play. Mount dial indicator on generator frame or drive end head with plunger in line with, and resting against, end of

of shaft. Move armature to its two extreme positions and read indicator (fig. 29). End play must be 0.003 inch to 0.010 inch. If it is not within these limits it indicates improper generator assembly. Inspect drive end and commutator end bearings for looseness in heads. Make sure drive end bearing is down against shoulder on armature shaft.

b. Electrical Tests and Adjustments (par. 33 c).

40. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Poles—4.

Brushes—4.

Lubrication—Add three to five drops of engine oil (SAE 30) to oilers. Pack plain ball bearings ½ full with high temperature grease when overhauling.

b. Mechanical.

Rotation—Counterclockwise at the drive end.

Brush length (new)—1 in.

Brush length (worn)—½-inch minimum.

Commutator diameter (new)—3.000 in.

Commutator diameter (worn)—2.750-inch minimum. NOTE: *Can be used at smaller diameters if arcing at brushes is not excessive at full output.*

Brush spring tension (with new brushes)—71 to 76 ounces.

End play—0.003 in. to 0.010 in.

Commutator runout (total reading)—0.0005-inch maximum.

Commutator mica undercut—1/32 in. to 3/64 in.

Shaft diameter (commutator end)—0.9838 to 0.9840 in.; (drive end) —0.9840 to 0.9842 in.

Bearing diameter (commutator end)—0.9839 to 0.9843 in.; (drive end)—0.9839 to 0.9843 in.

c. Electrical.

Rated volts—24.

Ground polarity—Negative.

Control—Separately mounted current and voltage regulator.

Field fuse—None.

Condensers

GFR 4801, A, B, GFR 4802, A, B and GFR 4803, A, B (one mounted in terminal box and connected from armature terminal to ground) —Capacity 0.9 to 1.1 microfarads.

GFR 4804A, B, C (two mounted in generator frame and connected from insulated brushes to ground)—Capacity 0.21 to 0.25 microfarads.

Field coil draw (complete set of coils)—0.93 to 1.02 amperes at 26.0 volts.

Motorizing draw—5.18 to 5.7 amperes at 26.0 volts.

Output*—30.0 volts, 50.0 amperes, 1,725 maximum revolutions per minute.

Field draw test hookup—Figure 36.

Motorizing draw test hookup—Figure 36.

Output test hookup—Figure 36.

Internal wiring diagram—Figure 70.

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*Do not operate at this output without ventilating fan and do not operate at larger outputs as to do so will burn armature and fields.

CHAPTER 3

REGULATORS

Section I

REGULATORS—BASIC PRINCIPLES

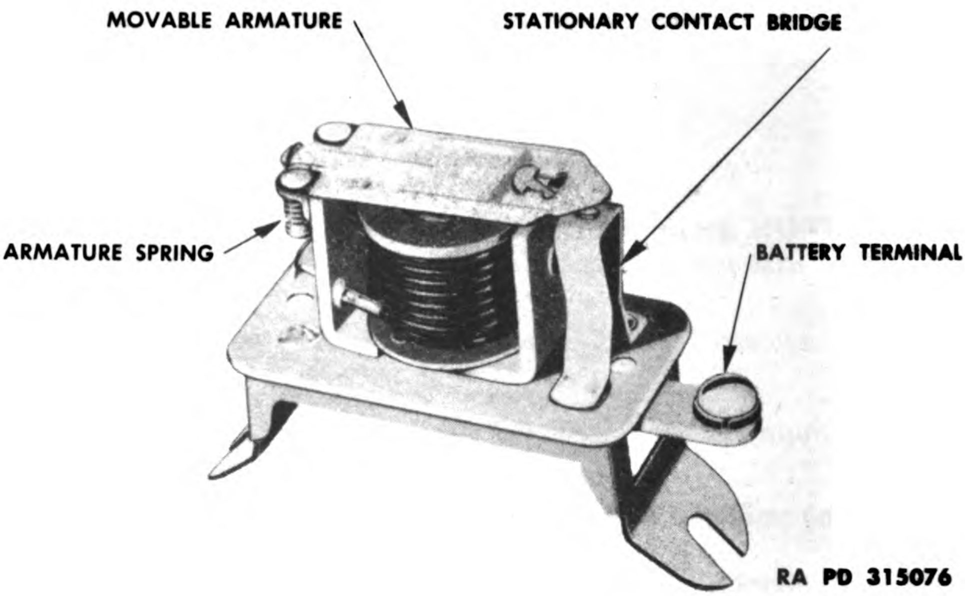

Figure 71—Group 1 Regulator (Cut-out Relay) with Cover Removed

41. DESCRIPTION.

a. Construction.

(1) INTRODUCTION.

(a) Regulators consist of 1, 2, or 3 units mounted on the same base and under the same cover. The three units are the cut-out relay, the voltage regulator, and the current-limiting regulator. Group 1 regulators have only the cut-out relay unit and are used with third brush generators (fig. 71). Group 2 regulators have a cut-out relay and a two-charge voltage regulator unit. They are also used with third brush generators (fig. 72). Groups 3 (fig. 73) and 4 (fig. 74) have three units; these are:

REGULATORS—BASIC PRINCIPLES

the cut-out relay, voltage regulator, and current limiting regulator. These last two groups are used with shunt-type generators.

(2) CUT-OUT RELAY.

(a) The cut-out relay unit consists of an electromagnet and a set of contacts. One of the contacts is mounted on a stationary bracket while the other is mounted on a movable armature which is controlled by the electromagnet. The contacts are usually mounted on spring arms so that as the contacts open and close a slight wiping action is produced. The heavy duty regulators in group 4 have two of the above sets of contacts. These two sets operate simultaneously and in parallel and two are used to reduce voltage loss.

(b) The electromagnet of the cut-out relay has two windings; one, the shunt coil which is connected across the generator output like a

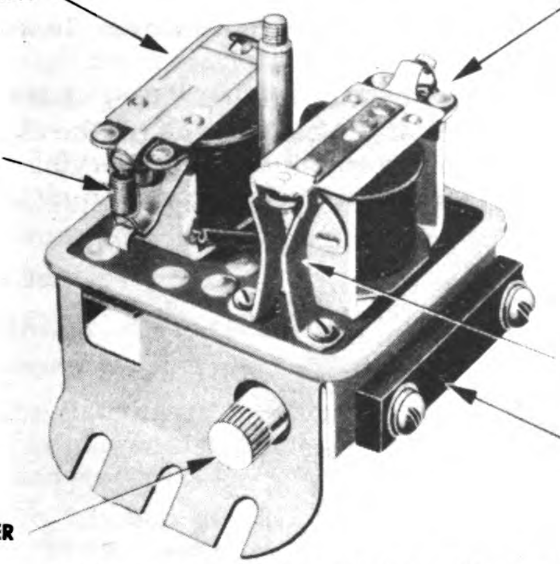

Figure 72—Group 2 Regulator with Cover Removed

voltmeter, and the other a series coil connected in series with the generator output like an ammeter. These two coils are wound in the same direction so that when the generator is charging the battery, the magnetism of the series coil increases the total magnetism. When the battery discharges back through the generator the magnetism of the series coil is reversed and the resultant magnetism of the two coils is reduced. This results in a decreased magnetic pull on the armature and spring action opens the contacts.

(3) VOLTAGE-REGULATOR UNIT.

(a) The voltage regulator consists of an electromagnet and a set of contacts. The electromagnet has a winding of many turns of fine wire and is connected across the charging circuit so that the system voltage controls the amount of magnetism. The contacts of the voltage regulator unit are connected in the generator field circuit so that the field circuit is completed through the contacts when they are closed, and through a resistor or combination of resistors when the contacts are opened.

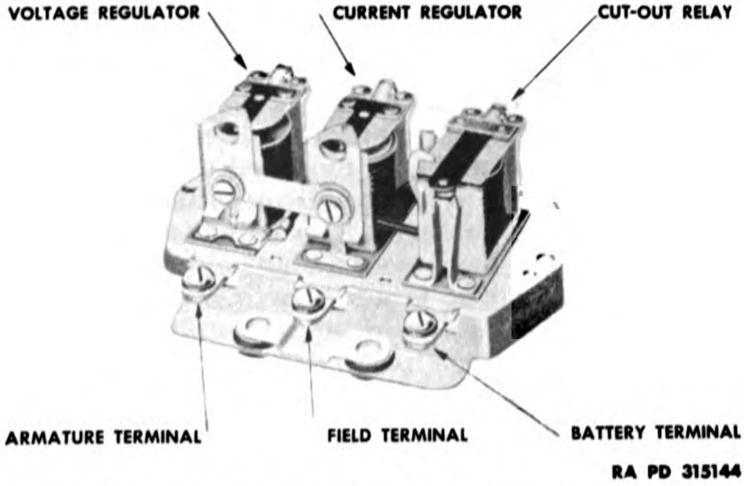

Figure 73—Group 3 Regulator with Cover Removed

(b) Due to the effect of heat on the operating characteristics of regulator windings, it is necessary to compensate for the changes in coil resistance when the regulator is operating under varying temperature conditions. This is accomplished through the use of a nickel-iron mag-

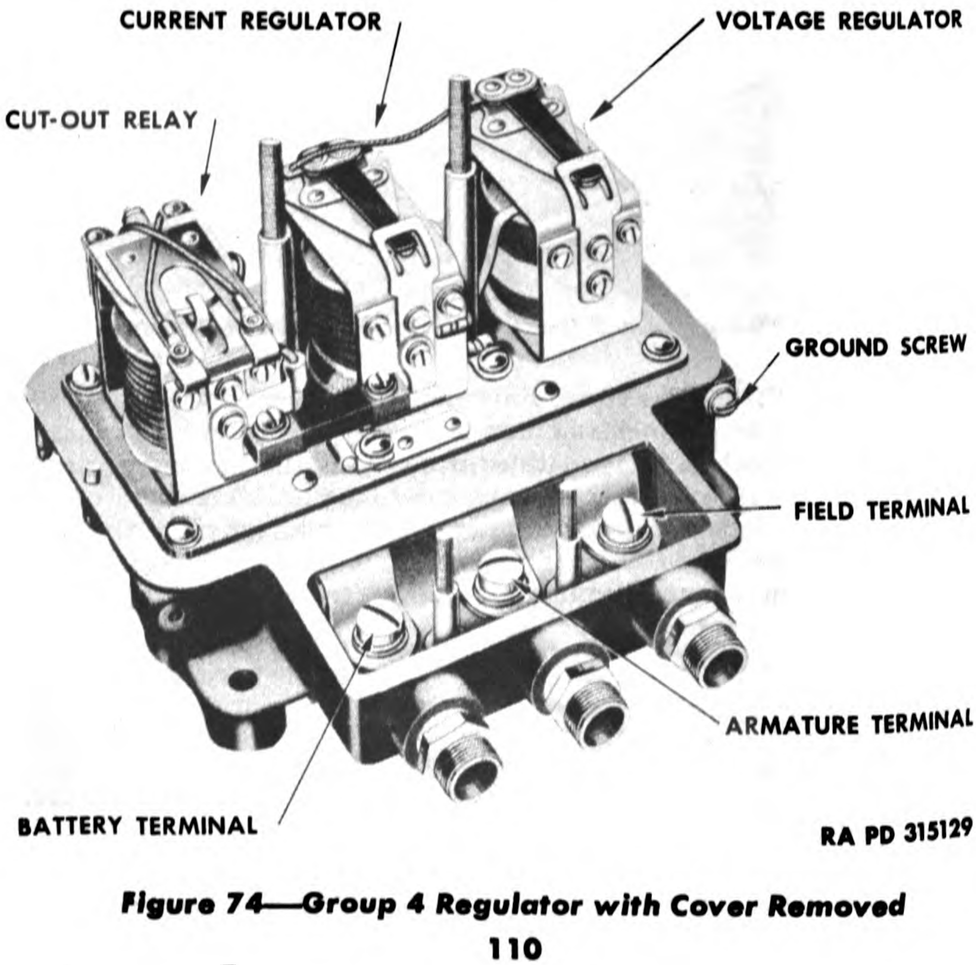

Figure 74—Group 4 Regulator with Cover Removed

netic bypass on the voltage-regulator unit. This shunt bypasses some of the magnetic flux when the unit is cold and allows most of the flux to act on the armature when the unit is hot. Thus when the coil is hot and not as efficient, the magnetic shunt reduces the amount of flux needed to operate the armature. The compensation is usually more than enough to offset the changes in regulator coil resistance due to heat. The excess compensation allows the regulator to operate at higher voltages under cold operating conditions than under hot conditions. This is necessary as it requires a higher voltage to charge a battery with its internal resistance increased by low temperatures.

(4) CURRENT-REGULATOR UNIT.

(a) The electromagnet of the current-limiting regulator unit consists of a winding of heavy wire that is connected in series with the generator output. The contacts of the unit are connected in the field circuit so that when the contacts are closed, the field circuit is completed through the contacts and when the contacts are opened the field circuit is completed through a combination of resistors. The current-regulator unit is interconnected with the voltage-regulator unit and appears and operates much the same except for the type of windings.

b. General. Regulators differ in size and design and in their internal connections but all include one or more of the three basic units just described.

42. THEORY AND OPERATION.

a. Theory.

(1) The function of a cut-out relay in automotive type electrical equipment is to automatically close and open the circuit between the generator and storage battery.

(2) The function of the voltage-regulator unit used on group 2 regulators is to reduce the generator output when the battery is full and the maximum output is not needed. On groups 3 and 4 regulators the voltage-regulator unit holds the generated voltage at a predetermined value as long as the circuit values allow the voltage to build up to the operating voltages.

(3) The function of the current-limiting regulator unit is to limit the generator output to the maximum safe value.

b. Operation.

(1) CUT-OUT RELAY UNIT.

(a) When the generator is not running, the cut-out relay contacts are held open by a spring. When the generator is started the voltage builds up at the armature terminal and in the shunt coil and as soon as it reaches the value for which the cut-out relay is calibrated there is sufficient magnetism created by the shunt coil to pull down the armature, closing the contacts which automatically connects the generator to the battery. With the contacts thus closed the current in the series coil flows from the generator to the battery or in the same direction as the current in the shunt coil, so that the pull on the armature is increased by the magnetism of the series coil.

(b) When the engine is stopped and the generator loses speed, the voltage falls. As soon as the generator voltage drops below the battery terminal voltage, the current flows from the battery to the generator, reversing the direction of current in the series coil. The magnetism created by the series coil opposes and reduces the magnetism of the shunt coil. This reduces the magnetic pull on the armature to a point where the spring action opens the contacts.

(2) VOLTAGE-REGULATOR UNIT.

(a) When the generated voltage rises to a predetermined value there is sufficient magnetism created by the voltage regulator winding to pull the armature down. This opens the contacts and inserts resistance in the field circuit of the generator thus reducing the field current. On group 2 regulators the generated output remains at this lower value. The generator continues to charge at a reduced rate (fig. 3) until some external operation, such as an increased load on the battery, lowers the generated voltage to a point where the electromagnet can no longer hold the contacts open. Spring action closes the contacts and the generator again charges at its higher rate.

(b) Due to the regulator design, and the values of the resistance unit and generator field current, the contacts on groups 3 and 4 regulators do not remain open but close immediately upon the lowering of the generated voltage. This causes the generated voltage to immediately rise to the point where the contacts are again opened. These cycles occur at high enough frequencies to hold the generated voltage to a constant value and will continue as long as the voltage of the circuit is high enough to keep the voltage-regulator unit in operation. With the addition of a current load great enough to lower the battery voltage below the operating voltage of the unit, the voltage regulator contacts will remain closed and the generator will maintain a charging rate as limited by its speed or by the current-limiting regulator.

(3) CURRENT-REGULATOR UNIT.

(a) When the generator output reaches a predetermined value the current in the winding produces enough magnetism to overcome the spring tension and pull the armature down. This opens the contacts and inserts resistance in the field circuit of the generator. With the field current reduced by the resistance, the generator output falls and there is no longer enough magnetism to hold the contacts open. As soon as the spring closes the contacts, the output rises and the cycle is repeated. These cycles occur at high enough frequencies to limit the output to a minimum fluctuation.

CHAPTER 3

REGULATORS (Cont'd)

Section II

REGULATORS—GROUPS 1 AND 2

43. DESCRIPTION AND DATA.

a. Description (figs. 71 and 72).

(1) Group 1 regulators are cut-out relay units only and do not regulate the generator output. The only generator regulation is supplied by the generator third brush. These cut-out relays are mounted on a base and are covered to keep out dirt and moisture. This unit is usually mounted directly on the generator frame.

(2) Group 2 regulators are combination cut-out relays and two-charge voltage regulators. Both units are mounted on the same base and under the same cover. The cover is sealed to prevent dirt and moisture from entering. The complete unit may be mounted on the generator frame or separate from the generator. The carbon-resistance unit and the field fuse are accessible without removing the cover.

(3) For model numbers of group 1 and group 2 regulators, see paragraph 1.

b. Data.

Volts—6.

Carbon resistor (group 2 only)—Marked 1.85, resistance 1.85 to 2.10 ohms.

Fuse (group 2 only)—5 ampere. Do not use fuse substitute.

Shunt coil resistance (A terminal to ground)

Group 1—35 to 39 ohms.

Group 2—15.9 to 17.8 ohms.

Cut-out relay unit

Contacts close—6.5 to 7.25 volts.

Contacts open—0.5 to 2.5 amperes discharge.

Contact gap—0.015-inch minimum.

Voltage regulator unit (group 2 only)

Contacts open—High to low charge.

Temp.	Volts	Tolerance (volts)
50° F.	8.65	±0.25
60° F.	8.57	±0.25
70° F.	8.50	±0.25
80° F.	8.43	±0.25
90° F.	8.35	±0.25
100° F.	8.28	±0.25
110° F.	8.21	±0.25

Contacts close—Low to high charge.

1.2 to 1.4 volts below the reading in the high to low test.

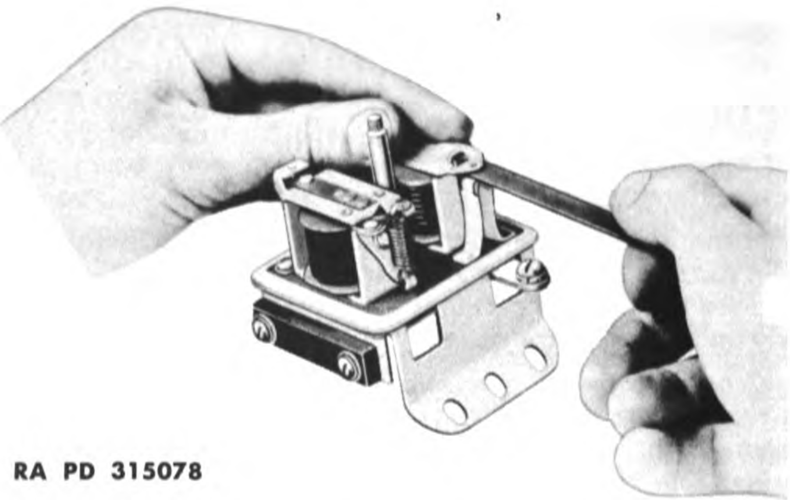

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Figure 75—Filing Contacts on Group 2 Regulators with Contact Point Dresser (41-D-1410)

44. CLEANING, INSPECTION AND TESTING.

a. Cleaning.

(1) Wipe outside of unit with cloth dampened in dry-cleaning solvent. Remove fuse cover and resistor from side of base. Clean fuse, fuse holder, and resistor.

(2) Remove cover. On CB 4014 unclinch ears, and on group 2 regulators cover is removed by removing nut at center of cover.

(3) Blow dust off windings and cover. Clean cover gasket.

(4) File contacts with contact point dresser (41-D-1410). File lengthwise and parallel to armature (fig. 75). Do not file excessively as it is not necessary to remove every trace of burning.

(5) Dampen linen tape with carbon tetrachloride and draw between contacts (fig. 76). Follow with clean dry tape to remove any residue.

b. Inspecting.

(1) Before making any tests or adjustments make a close visual inspection of the regulator with special emphasis being given to the following points. If any of these conditions are found, make necessary repairs or replace complete regulator.

(a) Evidence of burning or abnormal high temperatures at coils, contacts, insulation, external terminals or any other point.

(b) Loose connections which result from poor soldering.

(c) Loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.

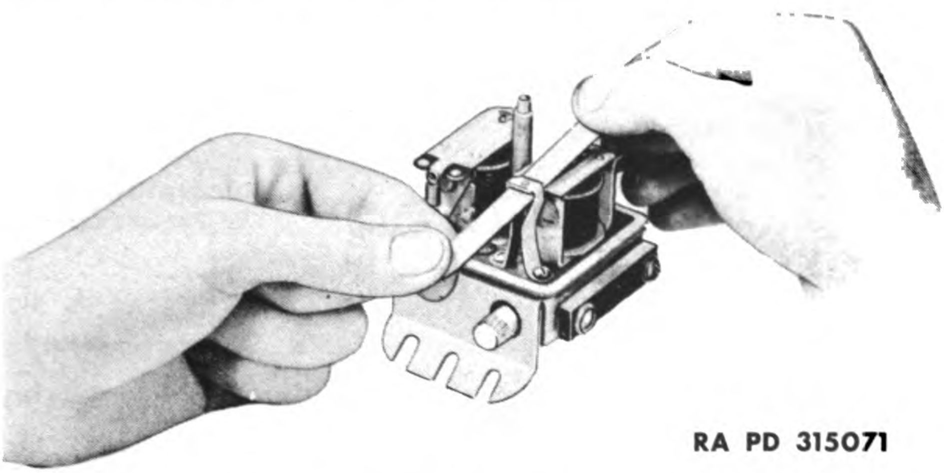

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Figure 76—Cleaning Contacts on Group 2 Regulators with Linen Tape

(d) Loose contacts.

(e) Misalined contacts.

(f) Bent armatures.

(g) Bent yokes.

(h) Bent hinges.

(i) Reversed bimetal hinge on circuit breaker unit. When correctly installed brass side must be up.

(j) Stripped or crossed threads on any screw or nut.

(k) Corrosion due to salt or acids.

(l) Evidence of water having been inside of cover.

(m) Broken or altered carbon resistors.

(n) Broken or incorrect field fuse. Use only 5 ampere fuse and do not use substitute.

(o) Broken gaskets.

(2) Install any parts that were removed during cleaning and inspecting.

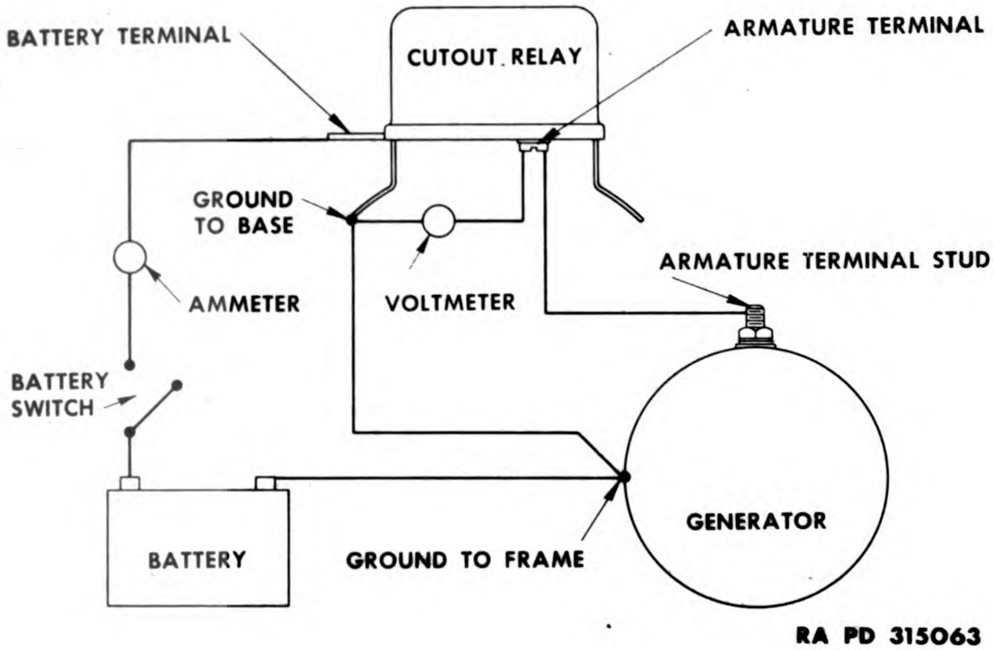


Figure 77—Test Hookup for Group 1 Regulators (Cut-out Relays)

c. Testing.

(1) CUT-OUT RELAY UNIT.

(a) Mount generator on test stand. Use GAS-type generator for testing group 1 regulators and use GDE-type regulator for testing group 2 regulators. On GDE-type generators connect generator field terminal to one end of a variable resistance and connect other end of resistance to regulator "field" terminal. If GAS-type generator is used omit this field connection. Connect generator armature terminal to regulator or cut-out relay A terminal. Connect ammeter in series with regulator B terminal and the battery. Ground regulator base to generator frame (figs. 77 and 78). Connect voltmeter from regulator A terminal to regulator base.

(b) Start generator and insert all resistance in field circuit. Decrease resistance slowly noting voltmeter reading just before change caused by closing of contacts. If GAS-type generator is used vary generator speed to change voltage and charging rate. Decrease resistance until ammeter shows a 10-ampere charge, then increase resistance slowly, noting amperage discharge just before cut-out relay opens and ammeter reading drops to zero. Closing voltage and opening amperage must be within limits specified (par. 43 **b**).

(c) Adjust closing voltage to limits specified (par. 43 **b**) by changing armature spring tension. This is done by bending lower spring hanger (fig. 79). Adjust opening current to figure specified by raising or lowering stationary contact (fig. 79). Be sure contact point gap is kept within limits (par. 43 **b**).

REGULATORS—GROUPS 1 AND 2

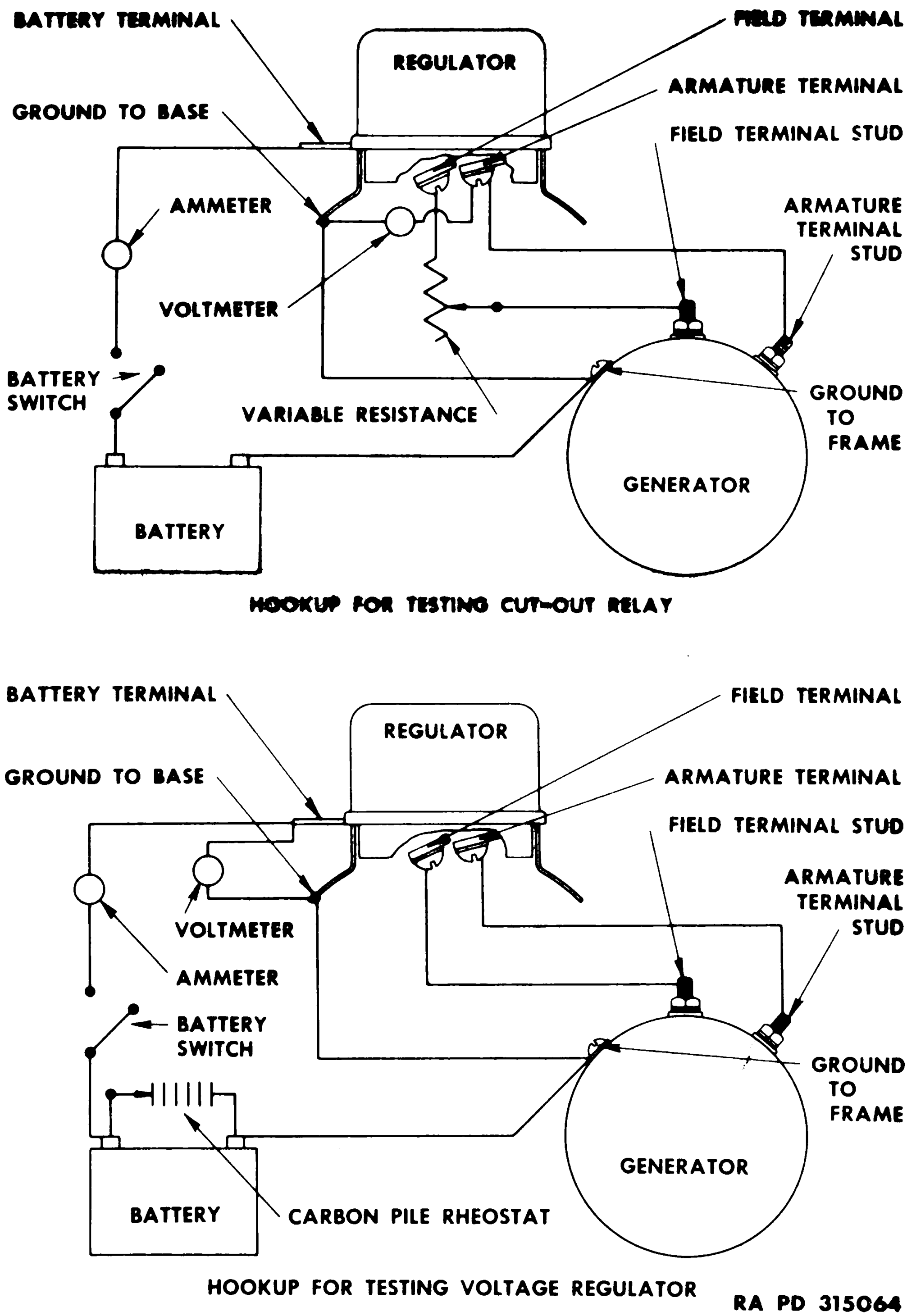
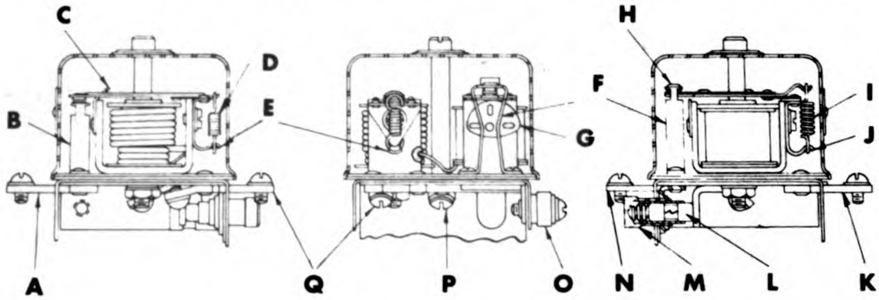


Figure 78—Test Hookups for Group 2 Regulators



A—BATTERY TERMINAL
B—CUT-OUT RELAY STATIONARY CONTACT BRIDGE
C—CUT-OUT RELAY ARMATURE STOP
D—CUT-OUT RELAY ARMATURE SPRING
E—CUT-OUT RELAY LOWER SPRING HANGER
F—VOLTAGE REGULATOR STATIONARY CONTACT BRIDGE
G—CONTACT GAP ADJUSTING CAM
H—VOLTAGE REGULATOR STATIONARY CONTACT
I—VOLTAGE REGULATOR ARMATURE SPRING
J—VOLTAGE REGULATOR LOWER SPRING HANGER
K—BATTERY TERMINAL
L—FUSE
M—FUSE HOLDER
N—ARMATURE TERMINAL
O—CARBON RESISTOR
P—FIELD TERMINAL
Q—ARMATURE TERMINAL

RA PD 315083

Figure 79—Adjustments of Group 2 Regulators

(d) If cut-out relay cannot be adjusted check further (pars. 45 and 46).

(2) VOLTAGE-REGULATOR UNIT (fig. 78).

(a) With regulator and generator connected as above change voltmeter connection from regulator A terminal to regulator B terminal. Test stand battery must be fully charged.

(b) Start generator and turn resistance all out. Insert resistance until contacts close and charging rate increases, then slowly decrease resistance noting voltage when regulator contacts open as indicated by a drop in the charging rate. Adjust this voltage to figure specified (par. 43 **b**) by bending lower spring hanger to change armature spring tension (fig. 79).

(c) When contact opening voltage has been adjusted, subtract 1.2 volts from reading obtained to get upper closing limit and subtract 1.4 volts from same reading to get lower closing limit. Increase field resistance slowly noting voltage at which contacts close and charging rate increases. This reading must be within limits just computed and is adjusted by turning brass cam on contact side of yoke (fig. 79). Do

not adjust contact gap when open to less than 0.005 inch. Apply one drop of air drying varnish to cam to prevent slipping.

(d) If regulator cannot be adjusted to above specifications inspect and check further (pars. 45 and 46).

45. TEST AND REPAIR OF COMPONENTS.

a. Resistance Tests.

(1) Inspect carbon resistance for cracks and alterations and to make sure it is marked correctly (par. 47). Check its resistance on ohmmeter (ST 284). Install new resistor if resistance is not within specifications.

(2) Measure resistance of shunt coils from A terminal to base. If resistance is not within limits specified for two coils in parallel (par. 47), one or both coils are faulty and complete regulator must be replaced.

b. Fuse. Inspect fuse to make sure it is not blown and replace if any doubt exists.

c. Contacts. File and clean contacts (par. 44 a (4) and (5)).

d. Check Continuity.

(1) With test probes touch A and B terminals and hold cut-out relay contacts closed. If lamp does not light, discard regulator. Open cut-out relay contacts. If lamp does not go out, discard regulator.

(2) Touch probes to F terminal and base. The lamp must light. Open voltage regulator contacts and lamp must go out or dim. If lamp does not act as described, check for correct fuse assembly and discard regulator if fuse is correct.

e. Adjust Armature Air Gap.

(1) CUT-OUT RELAY.

(a) With contacts open and armature against stop, measure gap between core and armature. Hold flat gage as near to hinge as possible. Adjust gap to 0.034 inch to 0.038 inch by bending armature stop (fig. 79). Make sure stop does not rub against armature or interfere with its movement.

(2) VOLTAGE REGULATOR.

(a) With armature spring installed and contacts closed, measure gap between core and armature with flat feeler gage. Adjust this gap to specified limits (par. 47) by raising or lowering stationary contact (fig. 79). This is done by expanding or contracting stationary contact bridge. Keep contacts alined for full face contact.

f. Adjust Contact Gap.

(1) CUT-OUT RELAY.

(a) With spring tension on armature and armature against stop, measure gap between contacts with feeler gage. Aline contacts for full face contact and adjust gap to at least 0.015 inch by expanding or contracting stationary contact bracket. This gap may be changed during adjustment of contact opening amperage.

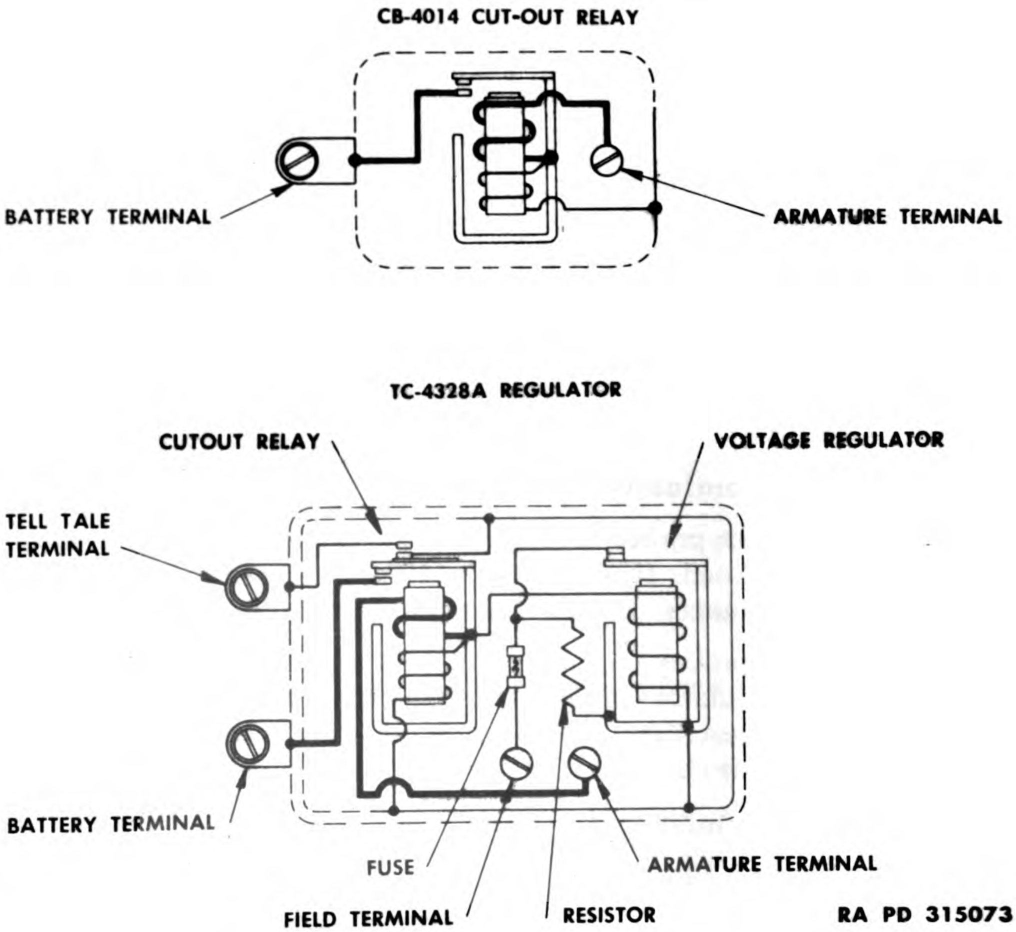


Figure 80—Internal Wiring Diagrams of Groups 1 and 2 Regulators

(2) VOLTAGE REGULATOR.

(a) Hold armature down and measure gap between contacts with feeler gage. This gap must not be less than 0.005 inch minimum but will probably be more than this after adjustment of contact closing voltage. Adjust gap by turning brass cam on contact side of yoke (fig. 79). After all adjustments are completed apply one drop of air drying varnish to cam to prevent slipping.

46. TESTS AND ADJUSTMENTS.

a. Refer to paragraph 44 c.

47. FITS, TOLERANCES, AND SPECIFICATIONS.

a. Tabulated Specifications.

	CB-4014	TC-4328A
Carbon Resistor		
Marked	....	1.85
Resistance (ohms)	....	1.85–2.10
Fuse	....	5 ampere
Shunt Coil Resistance		
2 coils in parallel (ohms)	....	15.9 to 17.8*
Circuit breaker coil (ohms)	35 to 39*	35 to 39
Voltage regulator coil (ohms)	....	29 to 33
Wiring and Hookups		
Internal	fig. 80	fig. 80
Circuit breaker test	fig. 77	fig. 78
Voltage regulator test	....	fig. 78
Circuit Breaker Unit		
Armature air gap† (inches)	0.034–0.038	0.034–0.038
Contact point gap‡ (inches)	0.015 min	0.015 min
Contacts close (volts)‡‡	6.5–7.25	6.5–7.25
Contacts open (amps discharge)‡	0.5–2.5	0.5–2.5
Voltage Regulator Unit		
Armature air gap** (inches)	....	0.044–0.046
Contact point gap†† (inches)	....	0.005 min
Contacts open—high to low charge‡‡		
50° F.	....	8.65 ± 0.25 volts
60° F.	....	8.57 ± 0.25 volts
70° F.	....	8.50 ± 0.25 volts
80° F.	....	8.43 ± 0.25 volts
90° F.	....	8.35 ± 0.25 volts
100° F.	....	8.28 ± 0.25 volts
110° F.	....	8.21 ± 0.25 volts
Contacts close—low to high charge††	....	1.2 to 1.4 volts below reading obtained for high to low charge

* Measure from "A" terminal to base.

† Measure gap with armature against stop—adjust by bending armature stop.

‡ Measure gap with contacts open—adjust by raising or lowering stationary contact, keeping contacts alined.

** Measure gap with contacts closed and spring tension on armature—adjust by raising or lowering stationary contact, keeping contacts alined.

†† Adjust by turning brass cam.

‡‡ Adjust by bending lower spring hanger.

CHAPTER 3

REGULATORS (Cont'd)

Section III

REGULATORS—GROUP 3

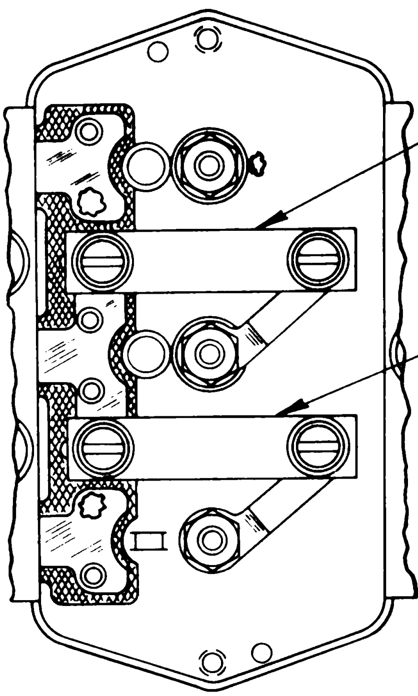


Figure 81—Resistor Assembly on Group 3 Regulators

48. DESCRIPTION AND DATA.

a. **Description** (fig. 73).

(1) Group 3 regulators have three units; cut-out relay, voltage regulator, and the current regulator unit. All three units are mounted on the same base and under the same cover. The cover is sealed to prevent dirt and moisture from entering. The carbon-resistance units are mounted on the bottom of the regulator and are easily accessible without removing the cover.

REGULATORS—GROUP 3

(2) Group 3 regulators are mounted separate from the generator but they must be used with the generator designed to operate with them. Do not substitute generators or regulators. These regulators must also be used with a battery of the correct ground polarity as the wrong polarity will cause the contacts to burn.

(3) For model numbers of group 3 regulators, see paragraph 1.

b. Data.

Volts

VRP 4001A, VRP 4002C, VRP 4004G, VRP 4006E—6.

VRS 4004B and VRX 4001A—12.

Ground polarity (positive).

Carbon resistors—two used—See figure 81 for assembly.

Regulator	R1 Marked	R1 Ohms	R2 Marked	R2 Ohms
VRP 4001A	38	36 to 40	7	6.5 to 7.5
VRP 4002C	38	36 to 40	7	6.5 to 7.5
VRP 4004G	38	36 to 40	7	6.5 to 7.5
VRP 4006E	60	57 to 63	15	13.5 to 16.5
VRS 4004B	60	57 to 63	30	28 to 32
VRX 4001A	80	76 to 84	20	19 to 21

Fuse—None used.

Circuit Breaker

Contact point gap—0.015 inch minimum.

Contacts close—VRP type 6.4 to 7.0 volts. When adjusting set at 6.4 to 6.6 volts.

VRS & VRX type 13.0 to 13.75 volts.

Contacts open—VRP type 4.1 to 4.8 volts or 4 to 6 amperes discharge.

VRS type 8.2 to 9.3 volts or 1.0 to 5.0 amperes discharge.

VRX type 3.5 to 5.0 amperes discharge.

Voltage Regulator—operating voltages

Temp. F.	50°	60°	70°	80°	90°	100°	110°	120°
VRP type*	7.41	7.38	7.35	7.32	7.29	7.27	7.24	7.21
VRS & VRX type†	14.59	14.54	14.50	14.46	14.42	14.37	14.33	14.29

*Allowable variation ±0.15 volts. †Allowable variation ±0.30 volts.

Current Regulator—Operating current.

VRP 4001A 34 to 36 amperes
VRP 4002C 34 to 36 amperes
VRP 4004G 24 to 26 amperes
VRP 4006E 31 to 33 amperes
VRS 4004B 16 to 18 amperes
VRX 4001A 29 to 31 amperes

49. CLEANING, INSPECTION, AND TESTING.

a. Cleaning.

(1) Wipe outside of unit with cloth dampened in dry-cleaning solvent. Remove resistors from bottom of base. Clean resistors but do not soak in dry-cleaning solvent.

(2) Remove two cover screws and seal and take off cover and gasket.

(3) Blow off regulator and cover with clean, dry, compressed air. Clean cover gasket.

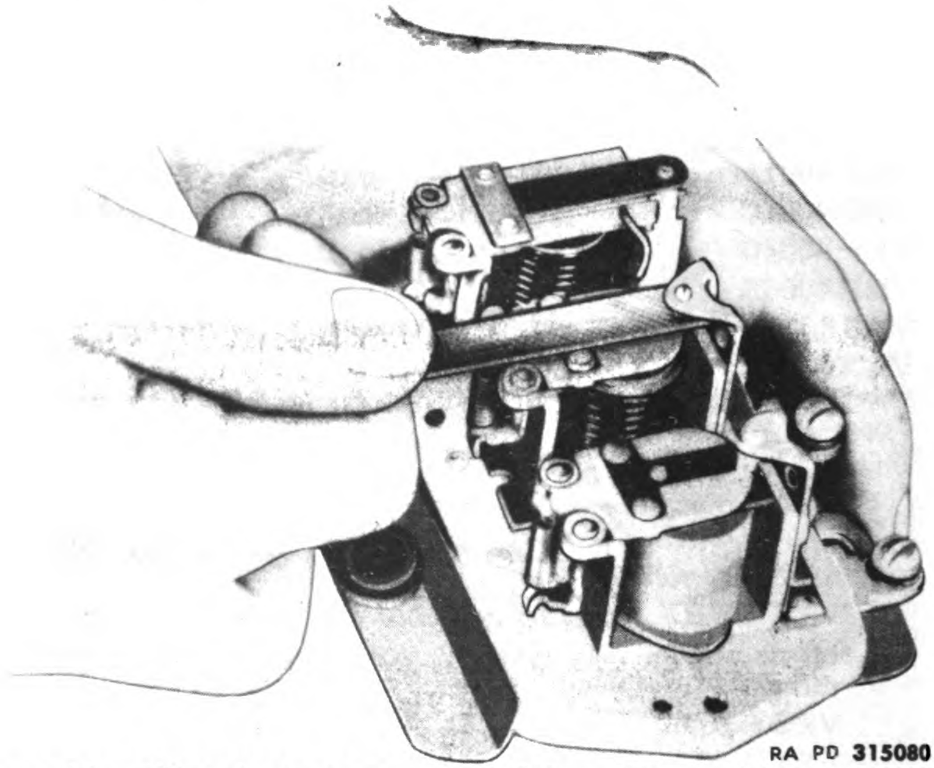


Figure 82—Filing Contacts on Group 3 Regulators with Contact Point Dresser (41-D-1410)

(4) File contacts with contact point dresser (41-D-1410) lengthwise and parallel to armature (fig. 82). File just enough so that contacts present a smooth surface toward each other. It is not necessary to remove every trace of burning. Clean contacts with linen tape and carbon tetrachloride. Dampen linen tape in carbon tetrachloride and draw tape between contacts (fig. 83). Repeat with clean dry tape to remove any residue.

b. Inspecting.

(1) Before making any tests or adjustments make a close visual inspection of regulator with special emphasis given to the following points. If any of these conditions are found make necessary repairs or replace complete regulator.

(a) Evidence of burning or abnormal high temperatures at coils, contacts, insulation, external terminals, or any other point.

(b) Loose connections which result from poor soldering.

(c) Loose nuts on bottom of magnet cores, loose rivets, or screws. All nuts and screws must have lock washers.

(d) Loose contact points.

(e) Misalinement of contact points. Bend stationary contact bracket to aline contacts for full face contact. If contact alinement is changed check air gap (par. 50 d).

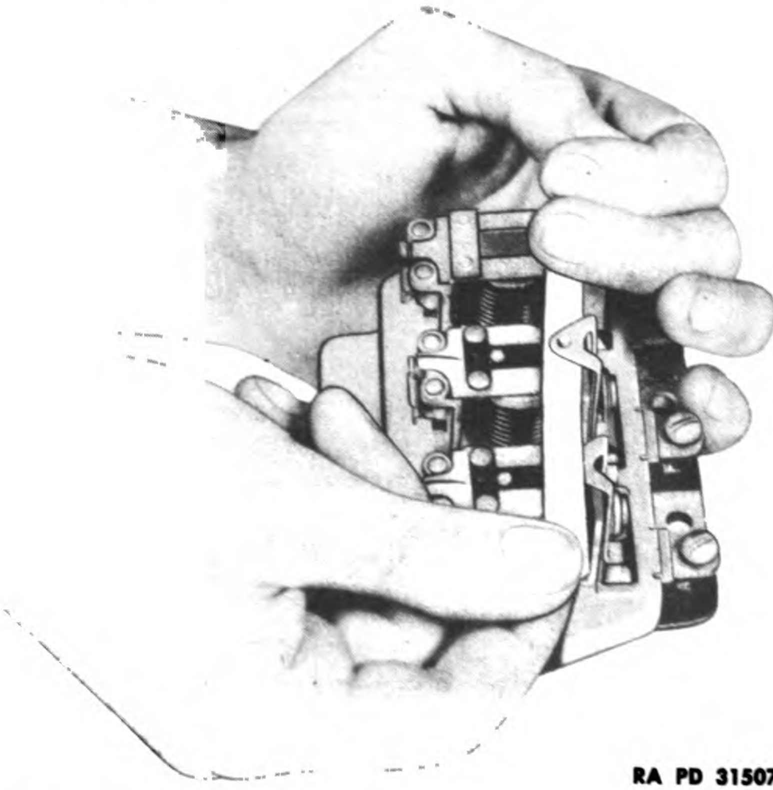


Figure 83—Cleaning Contacts on Group 3 Regulators with Linen Tape

(f) Bent armature.

(g) Bent field yoke.

(h) Bent armature hinges.

(i) Reversed bimetal hinge on circuit breaker unit. When correctly installed brass side must be up.

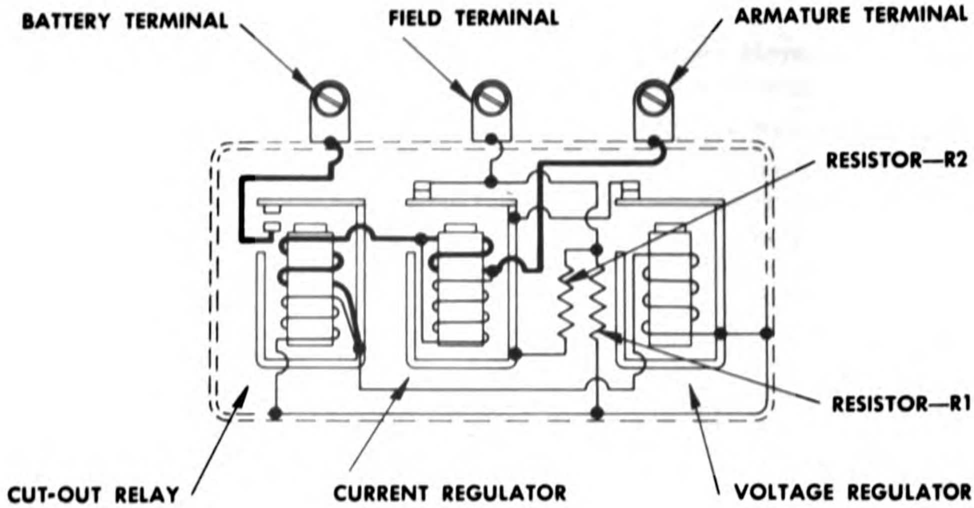
(j) Stripped or crossed threads on any screw or nut.

(k) Corrosion due to salt or acids.

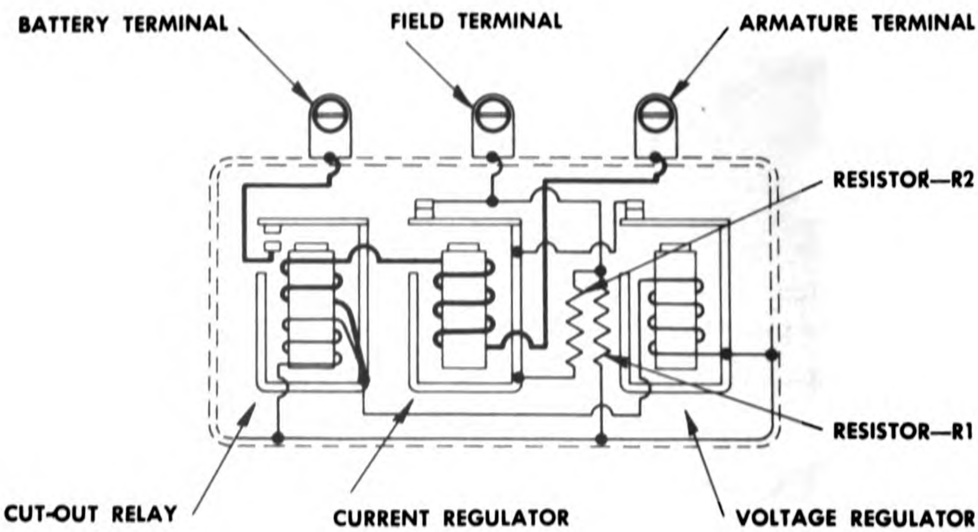
(l) Broken ground strap.

(m) Evidence of water having been inside of cover.

(n) Incorrect, bent, or distorted armature spring.



VRP AND VRX TYPE REGULATORS



VRS TYPE REGULATORS

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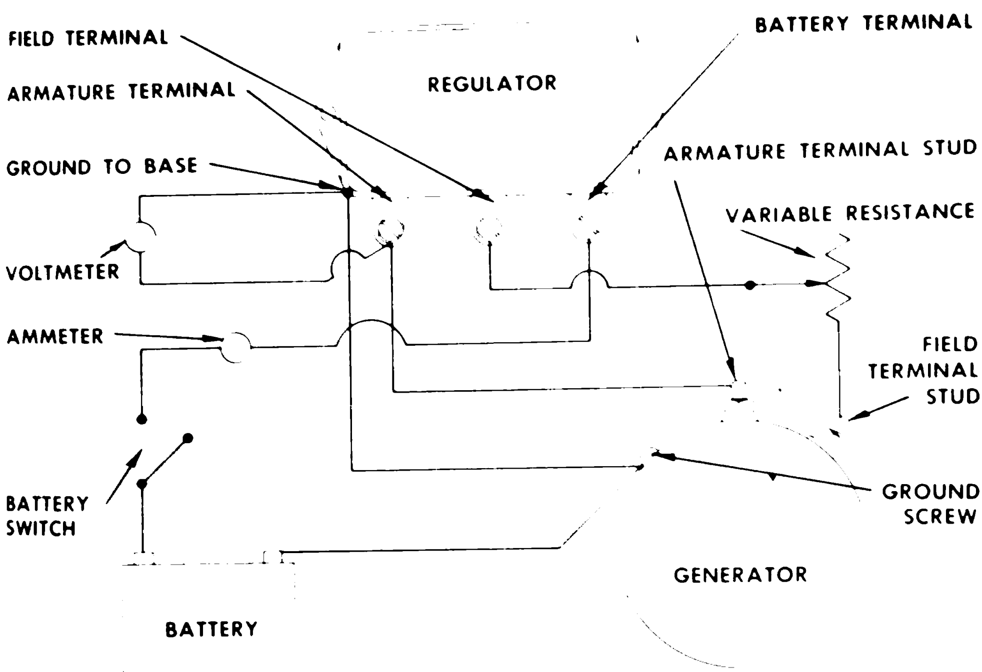
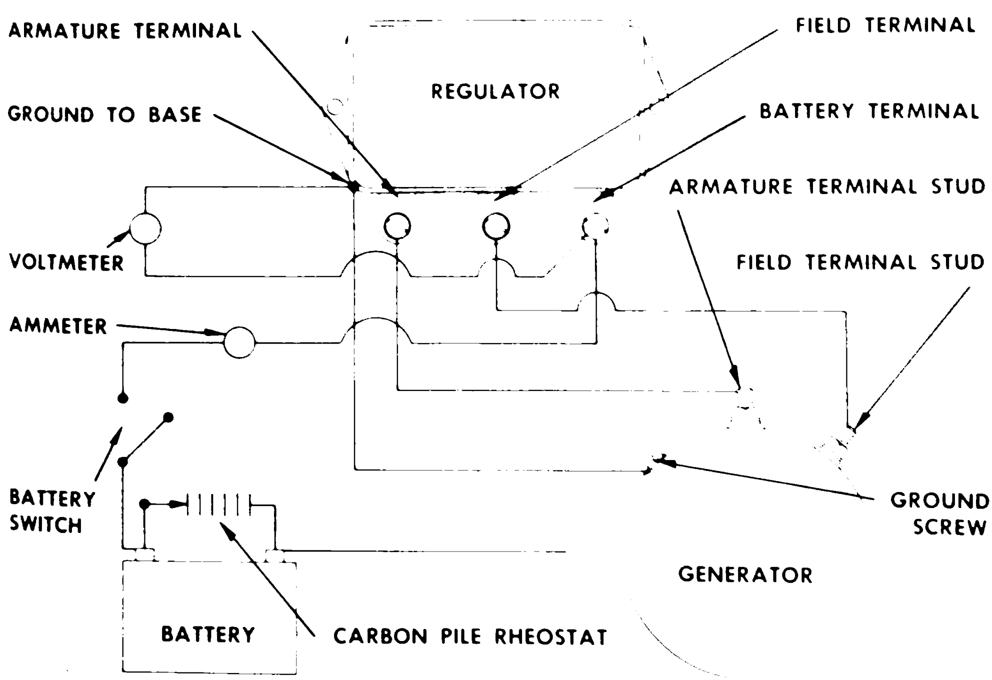
Figure 84—Internal Wiring Diagrams of Group 3 Regulators



HOOKUP FOR TESTING CUTOUT RELAY



HOOKUP FOR TESTING VOLTAGE AND CURRENT REGULATORS

RA PD 315065

Figure 85—Test Hookups for Group 3 Regulators

(o) Armature springs reversed. See specifications (par. 52) for identification of the three springs.

(p) Broken or altered carbon resistors. See specifications (par. 52) for correct marking and see figure 81 for correct assembly. If resistors appear altered check their resistance (par. 50 **a**).

(q) Broken gaskets.

(r) Incorrect wiring connections between units. See figure 84 for correct wiring diagram.

(2) Install any parts that were removed during cleaning and inspecting. Be sure resistors are installed as in figure 81 and be sure armature springs are in bottom of mounting grooves.

c. Testing.

(1) CUT-OUT RELAY UNIT (fig. 85).

(a) Mount generator on test stand. Be sure to use a group 2A generator of type noted in regulator specifications (par. 52). Connect battery to test stand for voltage and polarity noted in tabulation (par. 52). Mount regulator on test stand in vertical position with terminals at side. Connect generator field terminal to one end of a variable resistance and connect other end of resistance to regulator field terminal. Connect generator armature terminal to regulator armature terminal. Connect battery lead to ammeter and connect other side of ammeter to regulator battery terminal. Ground regulator base to generator frame with short lead. Connect voltmeter from regulator base to regulator armature terminal.

(b) Polarize generator to prevent cut-out relay contacts from vibrating and burning. To polarize generator close battery switch, disconnect generator field lead from variable resistance, then momentarily touch lead to regulator battery terminal. Reconnect lead to variable resistance.

(c) Start generator and insert all resistance in field circuit. Decrease resistance slowly, noting voltmeter reading just before change caused by closing of cut-out relay contacts. Decrease resistance until ammeter shows a reading of 15 amperes, then increase field resistance, noting voltmeter reading just before change caused by opening of cut-out relay. These operating figures must be within the limits specified (par. 52).

(d) Adjust closing voltage by changing armature spring tension. This is done by bending lower spring hanger (fig. 86). Adjust opening voltage by changing contact point gap. This is changed by expanding or contracting stationary contact bridge (fig. 86). Keep contacts alined and do not adjust gap between contacts to less than 0.015 inch when open.

(e) If cut-out relay cannot be adjusted check regulator further (pars. 50 and 51).

(2) VOLTAGE- AND CURRENT-REGULATOR UNITS (fig. 85).

(a) Remove resistance from field circuit and change voltmeter connection from regulator armature terminal to regulator battery terminal. Connect a variable load resistance across battery terminals.

(b) Close test stand battery switch and operate generator at about 2,500 revolutions per minute. Set regulator operation to approximate

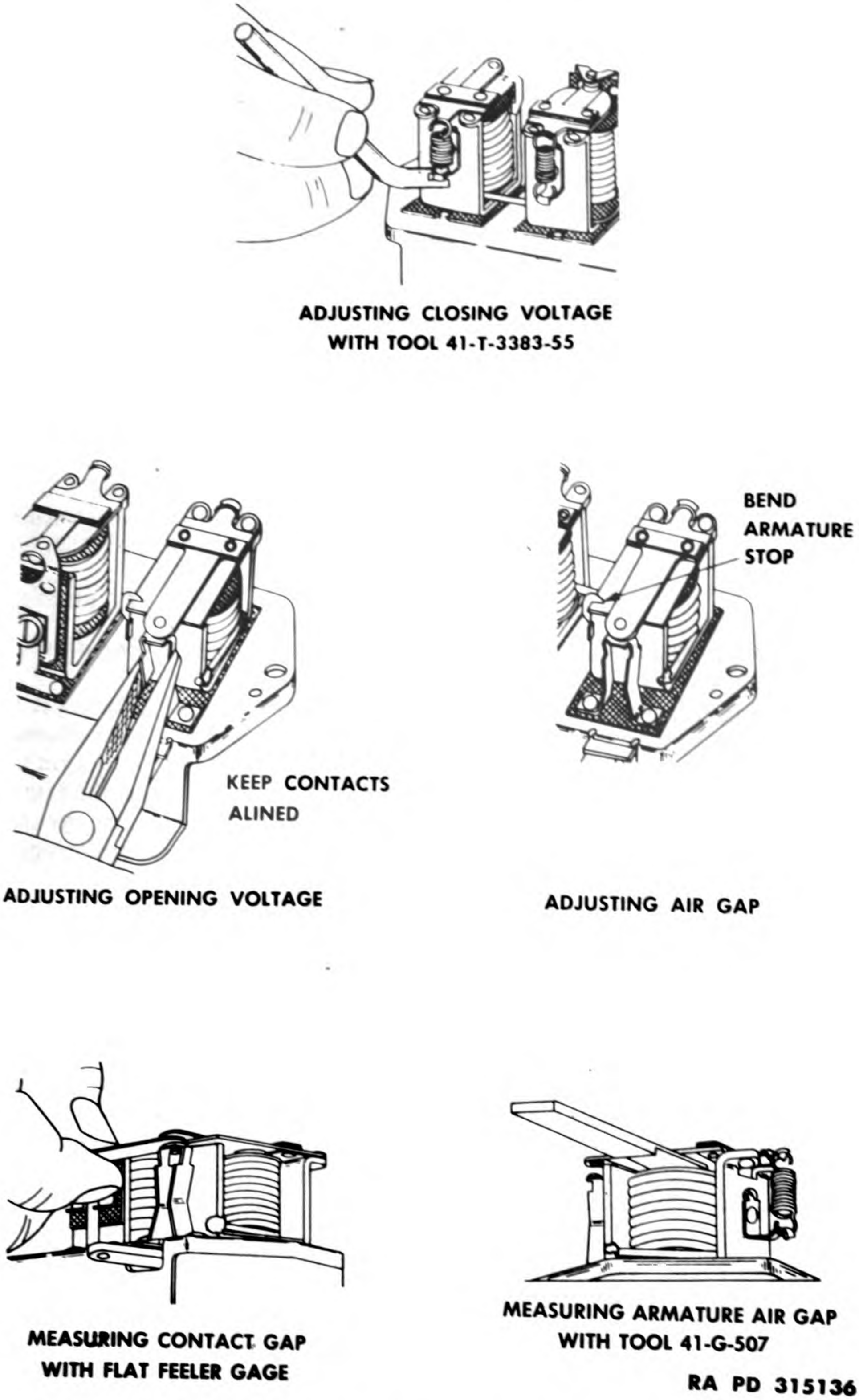
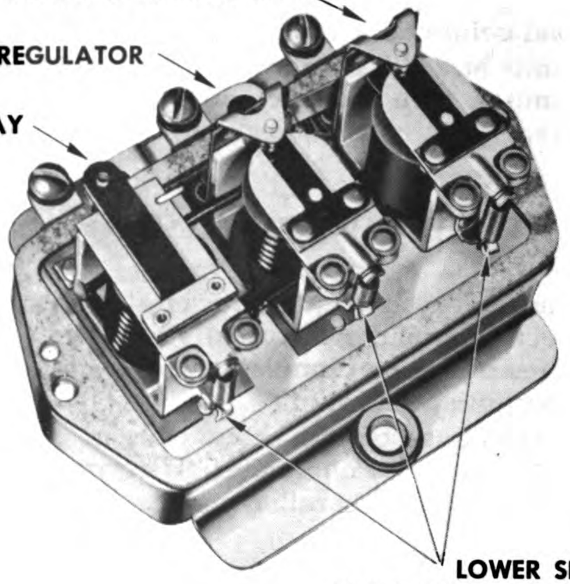


Figure 86—Cut-out Relay Adjustments on Group 3 Regulators



RA PD 315126

Figure 87—Operating Adjustments on Group 3 Regulators

operating figures so that it can be run for 15 minutes to bring it up to operating temperature. Hold current regulator contacts closed by pressing lightly on the back of armature where spring hooks on armature. Note voltmeter reading which should be near specified voltage (par. 52). If it is not, bend lower spring hanger to change spring tension on voltage regulator unit (fig. 87). Release current regulator armature and adjust load rheostat so voltmeter reading drops 0.5 to 0.7 volts below previous reading. Read ammeter which must be as specified for current regulator operation (par. 52). If it is not, bend lower spring hanger on current regulator to bring its operation within limits.

(c) Install regulator cover and operate generator at about 2,500 revolutions per minute. Adjust load on battery so that ammeter shows charge of 9.5 to 10.5 amperes. Operate in this manner for at least 15 minutes. Place thermometer near regulator to ascertain temperature of air near regulator. Thermometer must not touch regulator.

(d) Stop generator, then restart it and bring it up to operating speed. Adjust current to 10 amperes by changing load rheostat and read voltmeter and thermometer. If voltage is not within voltage regulator operating limits at temperature indicated by thermometer (par. 52), remove regulator cover and change armature spring tension by bending lower spring hanger (fig. 87). Install regulator cover, stop and start generator and adjust current before taking another reading.

(e) When voltage regulator is adjusted change load rheostat so voltmeter reading drops 0.5 to 0.7 volts. Read ammeter which must be within limits specified for current regulator operation. If it is not,

remove regulator cover and change armature spring tension by bending lower spring hanger (fig. 87). Install cover, stop and start generator and adjust load before taking another reading.

(f) Operate units at 2,500 revolutions per minute and 9.5 to 10.5 amperes for 5 minutes, then recheck and readjust, if necessary, the operation of voltage and current regulator units (par. 49 c (2) above).

50. TEST AND REPAIR OF COMPONENTS.

a. Resistance Tests.

(1) Inspect carbon resistances for cracks, alterations, and to make sure they are correctly marked and correctly installed (par. 52 and fig. 81). Check their resistance on ohmmeter, and install new resistors if resistance is not within specifications.

(2) Measure resistance of two shunt coils in parallel. Measure from A terminal to base with ohmmeter. If resistance is not within limits (par. 52) for two coils in parallel, replace regulator.

b. Contacts.

(1) File contacts with contact point dresser lengthwise and parallel to armature (fig. 82). File just enough so contacts present a smooth flat surface toward each other. It is not necessary to remove every trace of burning.

(2) Clean contacts with clean linen tape and carbon tetrachloride. Dampen tape in carbon tetrachloride and draw between contacts (fig. 83). Repeat with clean dry tape to remove any residue.

c. Continuity Tests.

(1) CHECK SERIES CIRCUIT. Touch test probes to armature terminal and to the cut-out relay yoke. If lamp does not light discard regulator. Touch probes to armature terminal and to battery terminal. Hold cut-out relay contacts closed. If lamp does not light, file and clean cut-out relay contacts (par. 50 b above). Try test again, and if an open is still present discard regulator.

(2) CHECK FIELD CIRCUIT. Touch test probes to field terminal and to regulator base. Lamp must light. Open voltage regulator contacts with fingers. Lamp must go out. Release voltage regulator and open current regulator contacts. Lamp must again go out or dim. If regulator does not act as above file and clean voltage regulator and current regulator contacts (par. 50 b above) and repeat test. Replace regulator if this does not cure trouble.

d. Adjust Armature Air Gap.

(1) CUT-OUT RELAY.

(a) With contacts open and armature against stop, measure gap between core and armature. Hold flat gage as near to hinge as possible (fig. 86). Adjust gap by bending armature stop (fig. 86). Make sure stop does not rub against armature and interfere with its movement.

(2) VOLTAGE REGULATOR.

(a) Connect six-volt battery and six-volt lamp in series with regulator base and field terminal to indicate when contacts are opened and closed (fig. 88).

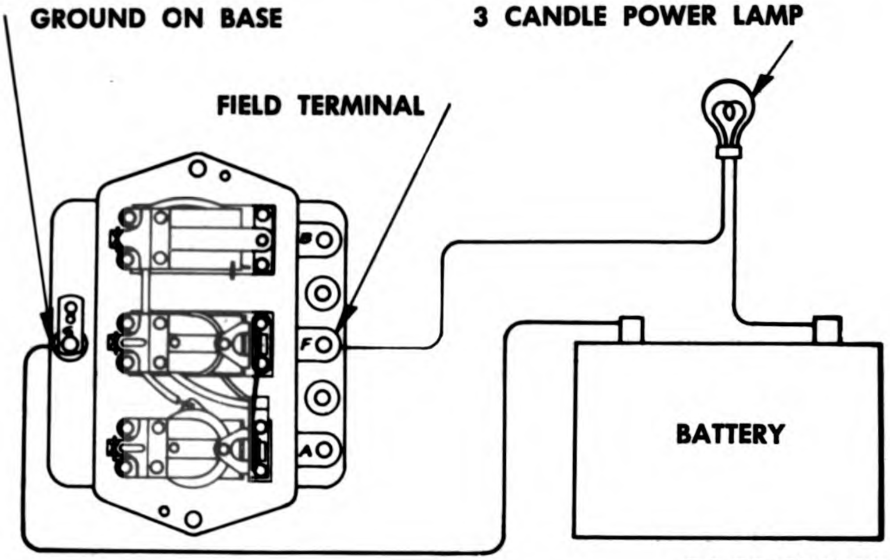


Figure 88—Hookup for Measuring Armature Air Gap on Voltage and Current-regulator Units—Group 3 Regulators

(b) With armature spring installed insert correct pin gage (par. 52) between core and armature on contact side and next to brass armature stop pin (fig. 89). Hold armature down with two fingers (fig. 89). Be careful not to touch contact spring. With low limit gage in place light must go out when armature is depressed and with high limit gage in place lamp must stay lighted. Adjust by slightly loosening screw holding stationary contact bracket and raising or lowering stationary contact (fig. 89). Keep contacts perfectly alined and check gap after tightening screw.

(3) CURRENT REGULATOR. Measure as described for voltage regulator using correct gage specified (par. 52).

e. Measure Contact Gap.

(1) CUT-OUT RELAY. With spring tension on armature and with armature against stop, measure gap between contacts with feeler gage. This gap must not be less than 0.015 inch minimum but may be more than this after adjusting contact opening voltage. Adjust by expanding or contracting bridge holding stationary contact (fig. 86). Keep contacts alined for full face contact.

(2) VOLTAGE AND CURRENT REGULATORS. With spring tension on armature, hold armature down against stop. Be careful not to touch contact spring. Measure gap between contacts with feeler gage (fig. 89). If this gap is less than 0.012 inch discard regulator. If gap is larger than 0.020 inch, inspect contact spring to see that it is straight and approximately parallel to armature. Discard regulator if contact spring is not in good condition.

51. TESTS AND ADJUSTMENTS.

a. Refer to paragraph 49 c.

REGULATORS—GROUP 3

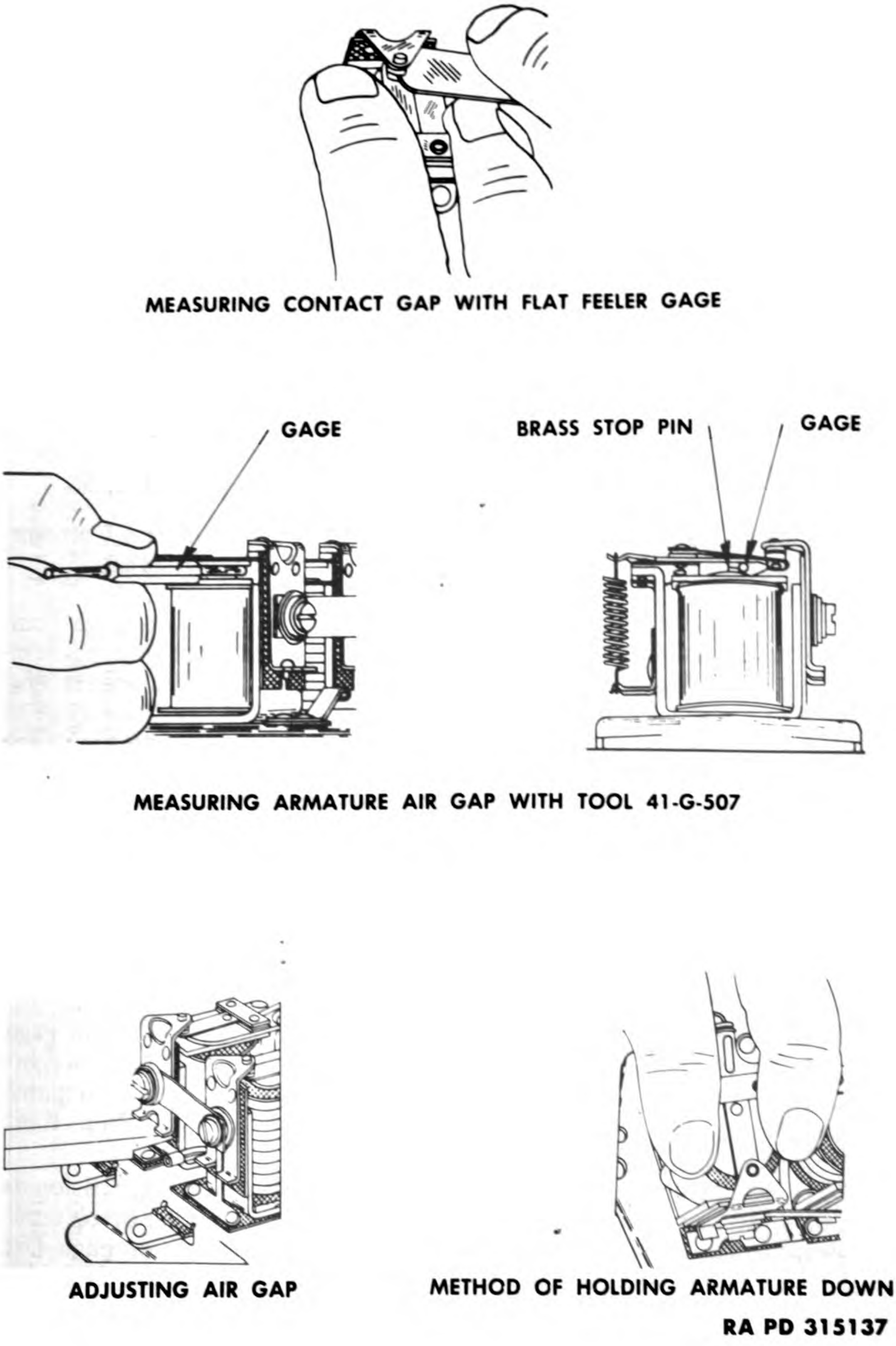


Figure 89—Voltage and Current-regulator Adjustments on Group 3 Regulators

52. FITS, TOLERANCES, AND SPECIFICATIONS.

a. Tabulated Specifications.

	VRP 4001A	VRP 4002C	VRP 4004G	VRP 4006E	VRS 4004B	VRX 4001A
Rated Voltage	6	6	6	6	12	12
Ground Polarity	Positive	Positive	Positive	Positive	Positive	Positive
Carbon Resistors	2 used	2 used	2 used	2 used	2 used	2 used
R1 marked	38	38	38	60	60	80
R1 ohms	36–40	36–40	36–40	57–63	57–63	76–84
R2 marked	7	7	7	15	30	20
R2 ohms	6.5–7.5	6.5–7.5	6.5–7.5	13.5–16.5	28–32	19–21
Resistance of 2 coils in parallel (ohms)	8.0–8.8	8.0–8.8	8.0–8.8	8.0–8.8	31.4–35.4	31.4–35.4
Wiring Diagrams						
Internal	Fig. 84	Fig. 84	Fig. 84	Fig. 84	Fig. 84	Fig. 84
C. B. Test Hookup	Fig. 85	Fig. 85	Fig. 85	Fig. 85	Fig. 85	Fig. 85
C. R. & C. R. Test Hookup	Fig. 85	Fig. 85	Fig. 85	Fig. 85	Fig. 85	Fig. 85
Circuit Breaker Unit						
Resistance of shunt coil (ohms)	29.8–33.0	29.8–33.0	29.8–33.0	29.8–33.0	111–125	111–125
Armature spring	12¾ turns	12¾ turns	12¾ turns	12¾ turns	12¾ turns	12¾ turns
Armature air gap (inches)	0.031–0.034	0.031–0.034	0.031–0.034	0.031–0.034	0.031–0.034	0.031–0.034
Contact point gap (inches)	0.015 min	0.015 min	0.015 min	0.015 min	0.015 min	0.015 min
Contacts close (volts)	6.4–7.0†	6.4–7.0†	6.4–7.0†	6.4–7.0†	13.0–13.7	13.0–13.7
Contacts open (volts)	4.1–4.8	4.1–4.8	4.1–4.8	4.1–4.8	8.2–9.3	8.2–9.3

REGULATORS—GROUP 3

	VRP 4001A	VRP 4002C	VRP 4004G	VRP 4006E	VRS 4004B	VRX 4001A
Voltage Regulator Unit						
Resistance of winding (ohms)	10.8–12.0	10.8–12.0	10.8–12.0	10.8–12.0	43.7–49.3	43.7–49.3
Armature spring	14½ turns	14½ turns	14½ turns	14½ turns	14½ turns	14½ turns
Armature air gap (inches)	0.048–0.052	0.048–0.052	0.048–0.052	0.048–0.052	0.048–0.052	0.048–0.052
Contact point gap (inches)	0.012 min	0.012 min	0.012 min	0.012 min	0.012 min	0.012 min
Operating voltage						
50° F.	7.41 ±0.15	7.41 ±0.15	7.41 ±0.15	7.41 ±0.15	14.58 ±0.30	14.58 ±0.30
60° F.	7.38 ±0.15	7.38 ±0.15	7.38 ±0.15	7.38 ±0.15	14.54 ±0.30	14.54 ±0.30
70° F.	7.35 ±0.15	7.35 ±0.15	7.35 ±0.15	7.35 ±0.15	14.50 ±0.30	14.50 ±0.30
80° F.	7.32 ±0.15	7.32 ±0.15	7.32 ±0.15	7.32 ±0.15	14.46 ±0.30	14.46 ±0.30
90° F.	7.29 ±0.15	7.29 ±0.15	7.29 ±0.15	7.29 ±0.15	14.42 ±0.30	14.42 ±0.30
100° F.	7.26 ±0.15	7.26 ±0.15	7.26 ±0.15	7.26 ±0.15	14.38 ±0.30	14.38 ±0.30
110° F.	7.23 ±0.15	7.23 ±0.15	7.23 ±0.15	7.23 ±0.15	14.34 ±0.30	14.34 ±0.30
120° F.	7.20 ±0.15	7.20 ±0.15	7.20 ±0.15	7.20 ±0.15	14.30 ±0.30	14.30 ±0.30
Current Regulator Unit						
Armature spring	12¾ turns	12¾ turns	12¾ turns	12¾ turns	10¾ turns	10¾ turns
Armature air gap (inches)	0.048–0.052	0.048–0.052	0.048–0.052	0.048–0.052	0.048–0.052	0.048–0.052
Contact point gap (inches)	0.012 min	0.012 min	0.012 min	0.012 min	0.012 min	0.012 min
Operating amperes	34.0–36.0	34.0–36.0	24.0–26.0	31.0–33.0	16.0–18.0	29.0–31.0
Generator Type Used With	GDZ, GEA	GDZ, GEA	GEW*	GEB*	GEH*	GDM*

* Must be group 2A generator.
† When adjusting set to 6.4 to 6.6 volts.

CHAPTER 3

REGULATORS (Cont'd)

Section IV

REGULATORS—GROUP 4

53. DESCRIPTION AND DATA.

a. Description.

(1) Group 4 regulators are heavy-duty units combining a cut-out relay, vibrating voltage regulator and vibrating current limiting regulator (fig. 74).

(2) These regulators have two sets of cut-out relay contacts. These two sets of contacts operate simultaneously and are connected in parallel to reduce voltage losses due to the higher current values encountered.

(3) Some group 4 regulators have a second winding on the current regulator unit. This winding is connected in the generator field circuit so that the rise and fall of the field current directly affects the magnetism of the current regulator unit and thus acts more quickly than the heavy output winding. This second winding is used to stabilize and increase the frequency of vibration of the current regulator armature and thereby minimize the fluctuations in generator output.

(4) VAD-type regulators have a second winding on the voltage regulator unit. This winding is connected in the circuit to increase the frequency of vibration of the voltage regulator armature and also to help eliminate radio interference. Later VAD-type regulators also have a heavy current winding on the voltage regulator unit. This winding is used to equalize the load when two or more generators and regulators are operated in parallel.

(5) For model numbers of group 4 generators, see paragraph 1.

b. Data.

Regulator	Rated Voltage	Ground Polarity	Resistors R1 Marked	Resistors R2 Marked	Resistors R3 Marked	R4 Marked	Circuit Breaker Closes Volts	Circuit Breaker Opens Amps	Voltage Regulator Operates	Current Regulator Operates Amperes	Generator Used With
VAC 4001A	12	Pos	100	15	0.65	...	13.0–13.5	0.5–6.0	Test A	29.0–31.0	GFK
VAD 4103A	24	Neg	135	70	100	100	25.7–26.7	16–21	Test B	50.0–53.0	GFR
VAD 4105A	24	Neg	135	70	100	100	25.7–26.7	16–21	Test B	50.0–53.0	GFR
VAD 4106A	24	Neg	135	70	100	100	25.7–26.7	16–21	Test B	50.0–53.0	GFR
VAD 4106B	24	Neg	135	70	100	100	25.7–26.7	16–21	Test B	50.0–53.0	GFR
VAL 4101A	24	Neg	135	60	70	...	26.0–27.2	3.0–5.0	Test C	25.0–27.0	GFZ
VAM 4101A	12	Neg	80	15	20	1	13.0–13.5	0.5–6.0	Test A	39.0–41.0	GGA
VRA 4102A	12	Pos	135	15	0.65	...	13.0–13.5	0.5–6.0	Test A	39.0–41.0	GBG
VRA 4105A	12	Neg	135	15	0.65	...	13.0–13.5	0.5–6.0	Test A	39.0–41.0	GBG
VRG 4102B	12	Pos	135	15	0.65	...	13.0–13.5	0.5–6.0	Test A	25.0–27.0	GEH-2*
VRG 4103C	12	Neg	135	15	0.65	...	13.0–13.5	0.5–6.0	Test A	34.0–36.0	GDM-2*
VRH 4101C	12	Pos or Neg	80	15	30	1	13.0–13.5	0.5–6.0	Test A	49.0–51.0	GDJ
VRH 4102A	12	Pos or Neg	80	15	30	1	13.0–13.5	0.5–6.0	Test A	54.0–56.0	GDJ
VRH 4102A-1	12	Pos or Neg	80	15	30	1	13.0–13.5	0.5–6.0	Test A	54.0–56.0	GDJ
VRH 4104B-1	12	Pos or Neg	80	15	30	1	13.0–13.5	0.5–6.0	Test D	54.0–56.0	GDJ
VRH 4104C-1	12	Pos or Neg	80	15	30	1	13.0–13.5	0.5–6.0	Test A	54.0–56.0	GDJ
VRH 4105A	12	Pos or Neg	80	15	30	1	13.0–13.5	0.5–6.0	Test A	49.0–51.0	GFM
VRH 4106A	12	Pos or Neg	80	15	30	1	13.0–13.5	0.5–6.0	Test A	54.0–56.0	GDJ
VRY 4201A	6	Pos	80	7	80	...	6.5– 7.0†	0.5–6.0	Test E	25.0–27.0	GEW*
VRY 4201B	6	Pos	80	7	80	...	6.5– 7.0†	0.5–6.0	Test E	31.0–33.0	GEB*
VRY 4203A	6	Neg	80	7	80	...	6.5– 7.0†	0.5–6.0	Test E	40.0–42.0	GEG*
VRY 4203B	6	Neg	80	7	80	...	6.5– 7.0†	0.5–6.0	Test E	40.0–42.0	GEG*

* Generator must be group 2B.
† When adjusting set to 6.5 to 6.7 volts.
Pos—Positive ground.
Neg—Negative ground.

Operating Temp F.	Voltages 50°	60°	70°	80°	90°	100°	110°	120°	Allowable Variation
Test A	14.31	14.28	14.25	14.22	14.19	14.16	14.13	14.10	±0.25 volts
Test B	28.58	28.54	28.50	28.46	28.41	28.37	28.33	28.29	±0.40 volts
Test C	29.38	29.34	29.30	29.26	29.21	29.17	29.13	29.09	±0.40 volts
Test D	14.56	14.53	14.50	14.47	14.44	14.41	14.38	14.35	±0.25 volts
Test E	7.41	7.38	7.35	7.32	7.29	7.26	7.23	7.20	±0.15 volts

54. CLEANING, INSPECTING, AND TESTING.

a. Cleaning. Wipe outside of regulator with cloth dampened in dry-cleaning solvent. Remove terminal shield cover (if used) and regulator cover, and blow off regulator with clean, dry, low-pressure air.

b. Inspecting.

(1) Inspect visually for following points. Repair or replace parts affected if these conditions are found (pars. 55 to 60).

(a) Evidence of burning or abnormal high temperatures at the coils, contacts, insulation, contact springs, external terminals, or any other point.

(b) Loose connections which result from poor soldering.

(c) Loose nuts, rivets or screws. All nuts and screws must have lock washers.

(d) Loose contacts.

(e) Misalinement of contacts.

(f) Armature stop rubbing against or interfering with circuit breaker armature.

(g) Bent armatures at either contact or hinge end.

(h) Field yoke bent.

(i) Bent or distorted armature hinges.

(j) Reversed bimetal hinge on circuit breaker unit. When correctly assembled brass side must be up.

(k) Stripped or crossed threads on any screw or nut.

(l) Corrosion due to salt or acid.

(m) Evidence of water having been inside of cover.

(n) Incorrect, bent, or distorted armature springs. In case of doubt install new springs.

(o) Broken or altered resistors.

(p) Broken gaskets.

(q) Reversed armature springs. See paragraph 61 for identification of correct springs.

(r) Incorrect assembly of armature. There must not be more than 0.002 inch gap between hinge spacer and top of yoke or between hinge and spacer.

(2) Inspect contacts on all three units. In normal use contacts will become grayed. If contacts are burned, dirty or rough, file with contact point dresser (41-D-1410) parallel and lengthwise to armature (fig. 90). File just enough so contacts present smooth surfaces toward each other. It is not necessary to remove every trace of burning. After filing, dampen a piece of linen tape in carbon tetrachloride and draw between contacts (fig. 91). Repeat with dry tape. Use clean tape for each set of contacts. Due to type of contact material used on VAD type regulators it is not possible to file contacts. Clean VAD contacts as above and replace unit if contacts are burned badly (par. 58).

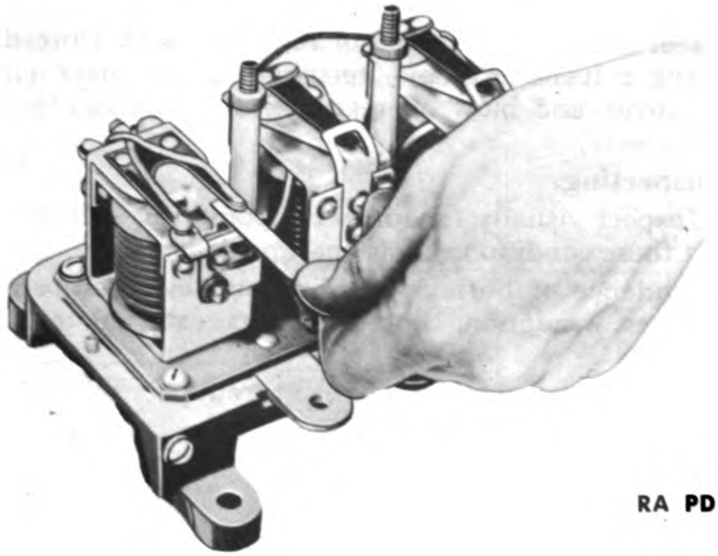


Figure 90—Filing Contacts on Group 4 Regulators with Contact Point File (41-D-1410)

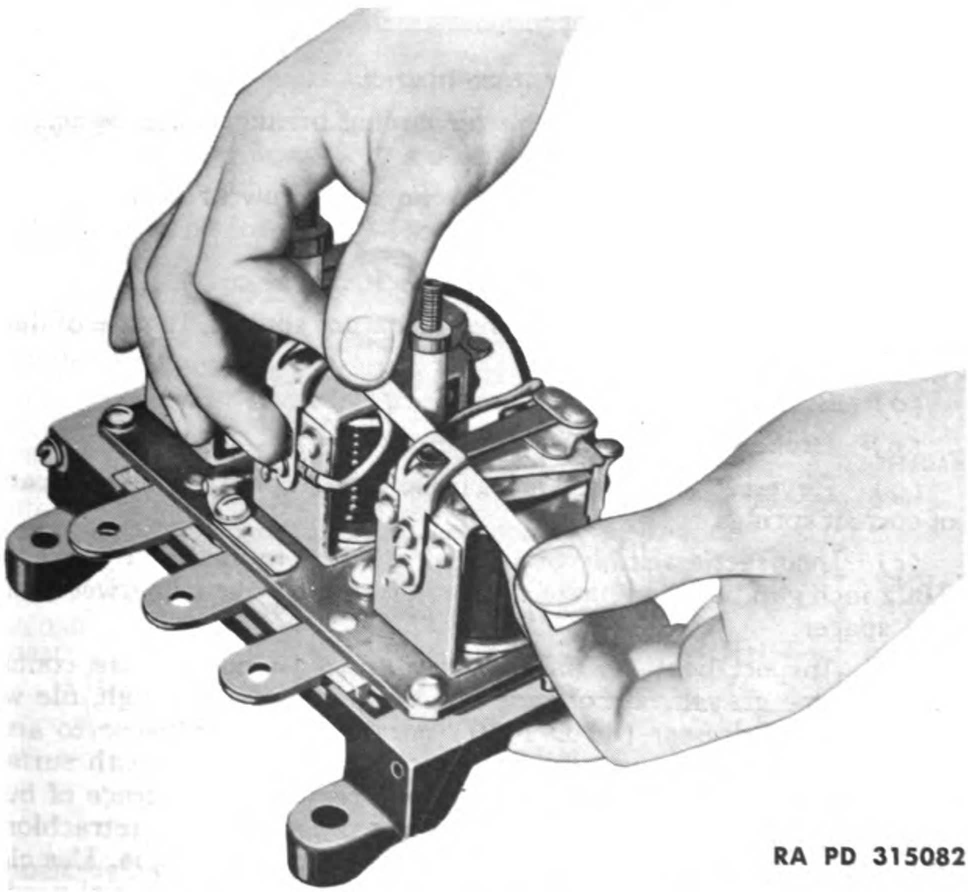


Figure 91—Cleaning Contacts on Group 4 Regulators with Linen Tape

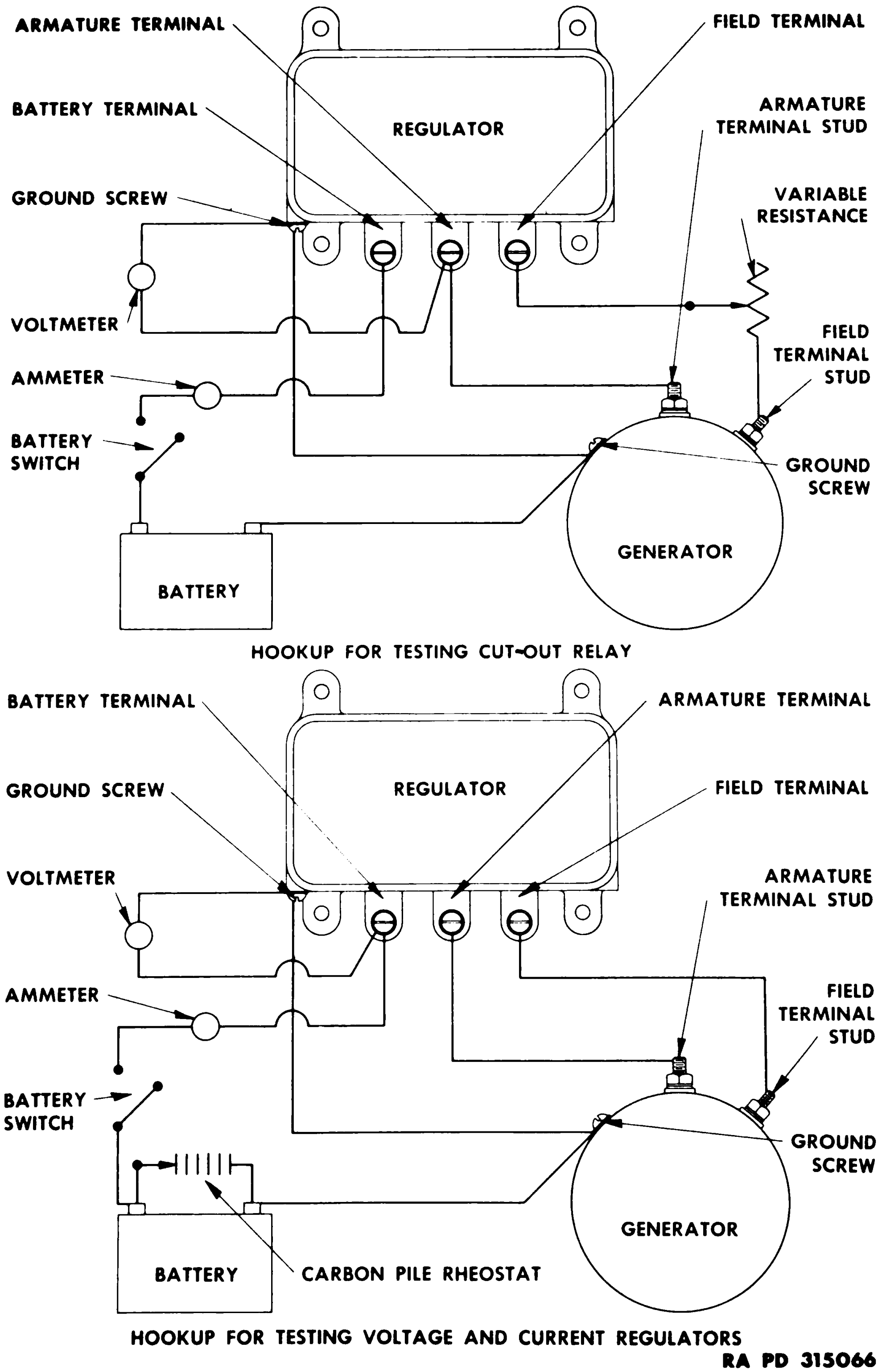


Figure 92—Test Hookups for Group 4 Regulators

c. Testing.

(1) CUT-OUT RELAY (fig. 92).

(a) Mount regulator on test stand in same position as it is mounted on vehicle or if this is unknown mount with base vertical and terminals hanging down. Use generator of type specified (par. 53 **b**) for regulator and mount on test stand. Connect battery to stand for correct voltage and polarity (par. 53 **b**).

(b) Connect test stand battery ground lead to generator frame and connect other battery lead to regulator terminal marked "Bat." Connect generator "Arm" terminal to regulator "Arm" terminal and connect variable resistance in series with generator "Field" and regulator "Field" terminals. Run a ground lead from generator frame to regulator ground screw. Connect voltmeter from regulator ground screw to regulator "Arm" terminal.

(c) Polarize the generator to prevent burning regulator contacts; remove generator field lead from variable resistance, close test stand battery switch and momentarily touch field lead to regulator "Bat" terminal, then connect field lead to variable resistance as above.

(d) Insert all the resistance in field circuit. Start generator and operate at 1,000 to 2,000 revolutions per minute. Decrease field resistance slowly noting voltmeter reading just before change caused by closing of the cut-out relay. Decrease resistance until ammeter shows a charge of one half current value stamped on regulator nameplate, then increase resistance slowly. Note amperage discharge just before contacts open and ammeter reading drops to zero.

(e) Adjust closing voltage to specified figure (par. 53 **b**) by turning thumb nut on lower end of armature spring (fig. 93). Some group 4 regulators have a lock nut on this adjustment which must be loosened to make adjustments. Recheck closing voltage after each adjustment.

(f) Adjust opening discharge current to specified figure (par. 53 **b**) by raising or lowering stationary contacts. Open test stand battery switch to prevent shorting. Bend stationary contact brackets to increase or decrease contact gap. Increasing contact gap increases opening discharge amperes. Keep contacts alined for full face contact and adjust both sets of contacts so they operate simultaneously. Do not adjust gap between contacts when open to less than 0.025 inch (0.080 inch for VAD type).

(g) Open test stand battery switch.

(2) VOLTAGE AND CURRENT REGULATORS (fig. 92).

(a) Remove variable resistance from field circuit. Change voltmeter connections so that it is connected to regulator base and "Bat" terminal. Connect variable load across battery. This load may consist of a carbonpile rheostat or a lamp bank.

(b) On units that have been completely overhauled close test stand battery switch and operate generator at 2,500 to 3,000 revolutions per minute. Hold voltage regulator contacts closed by pressing lightly on back of voltage regulator armature and read ammeter. If this is within two amperes of correct setting (par. 53 **b**) do not adjust.

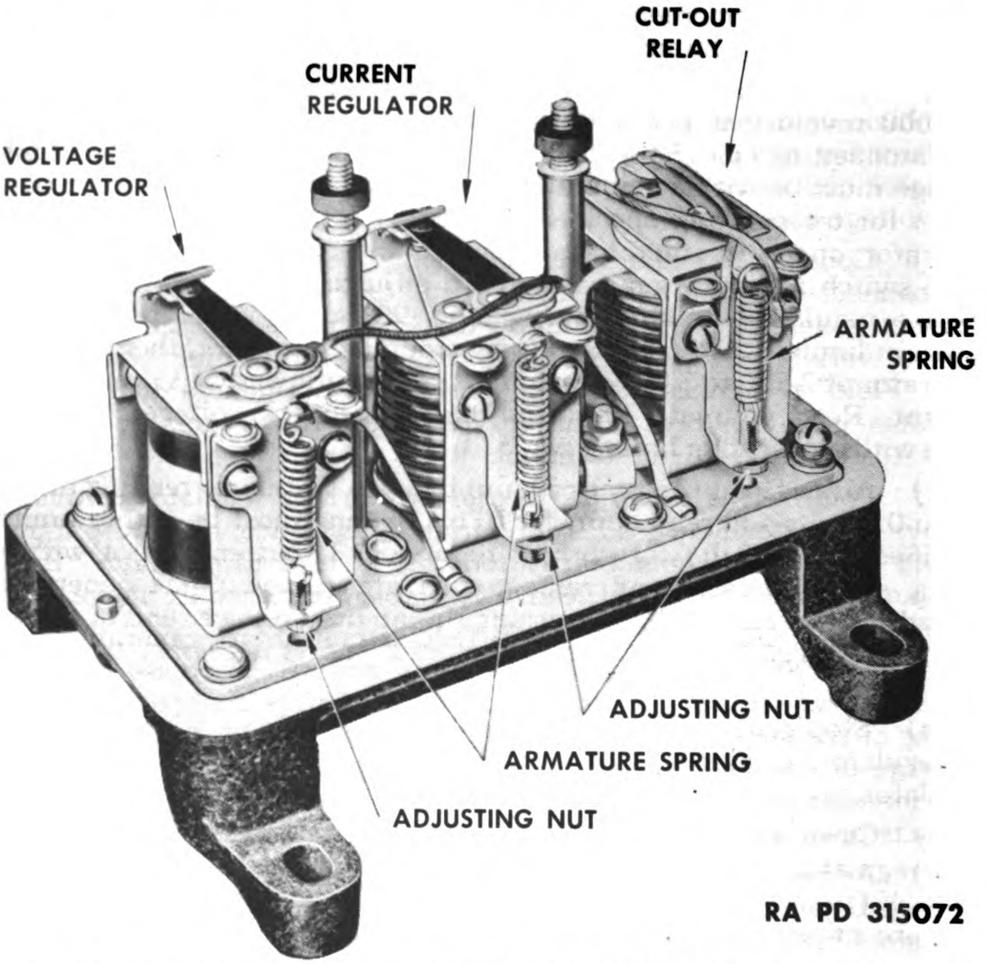


Figure 93—Operating Adjustments of Group 4 Regulators

If current setting is not within two amperes turn adjusting nut on lower end of armature spring. On some regulators it is necessary to first loosen lock nut. Release voltage regulator armature. Stop generator, then start and bring speed up to 2,500 to 3,000 revolutions per minute. Adjust current to one half the value stamped on regulator nameplate by changing load rheostat or lamp bank. Read voltmeter. If this reading is within 0.3 volts for 6 volt, 0.5 volts for 12 volt or 0.8 volts for 24-volt units of correct operating voltage (par. 53 **b**) do not adjust. If voltage is not within these approximate settings turn adjusting nut on lower end of armature spring (fig. 93). On some regulators it is first necessary to loosen lock nut. Stop generator and open test stand battery switch.

(c) Install cover gasket and cover on regulator.

(d) Close test stand battery switch and operate generator at 2,500 to 3,000 revolutions per minute. Adjust load rheostat or lamp bank so ammeter reads one half current regulator operating amperage (par. 53 **b**). Operate at this current for 30 minutes to bring regulator up to operating temperature.

(e) Place thermometer near regulator to ascertain temperature of air around unit. Thermometer must not touch regulator.

(f) Stop generator, then immediately start and bring up to 2,500 to 3,000 revolutions per minute. Adjust current to one half current regulator setting (par. 53 **b**) and read voltmeter and thermometer. This voltage must be within the limits specified for voltage regulator (par. 53 **b**) for temperature specified. If voltage is not within limits, stop generator, open test stand battery switch and remove regulator cover. Close switch and start generator. Turn adjusting nut on lower end of voltage regulator armature spring (fig. 93) until voltmeter reading is within limits. Check this setting by stopping generator, then operate generator at 2,500 to 3,000 revolutions per minute and at ½ maximum current. Read voltmeter and readjust and recheck voltage regulator if not within operating limits (par. 53 **b**).

(g) Adjust load rheostat or lamp bank so voltmeter reading drops 0.5 to 0.7 volts and read ammeter. This reading must be within limits specified (par. 53 **b**) for current regulator. If current is not within limits, stop generator and remove regulator cover. Start generator and adjust current setting by turning thumb nut on lower end of armature spring (fig. 93). On some regulators it is first necessary to loosen lock nut.

(h) Stop generator and open battery switch. Lock wire all screws on regulators designed to be lock wired and tighten lock nuts. Install regulator cover.

(i) Close test stand battery switch and operate generator at ½ current regulator setting for 5 minutes, then check voltage and current settings (par. 54 **c** (2) *(f)* and *(g)* above). Make any readjustments that are necessary and finish with a final 5 minute run and check.

(3) If regulator operation cannot be adjusted overhaul unit (pars. 55 to 60).

55. DISASSEMBLY.

a. Remove Terminal Cover. Unscrew two wing nuts and lift off.

b. Remove Bottom Cover Plate (VAD type only). Take out six screws and lift cover off.

c. Remove Cover. Cut seal wire and take off two hex nuts. Lift off cover and gasket.

d. Remove Regulator Sub-base Assembly.

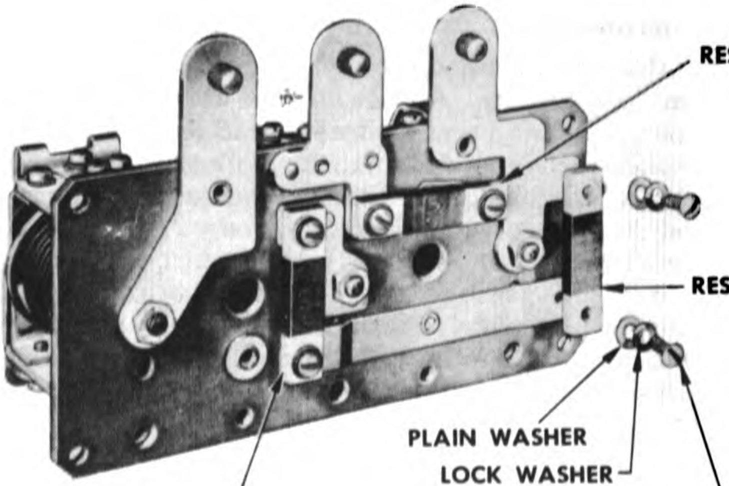
(1) On VAD type take out two screws connecting leads from under base to current and voltage regulator armature stops.

(2) On VAD type disconnect lead from filter terminal.

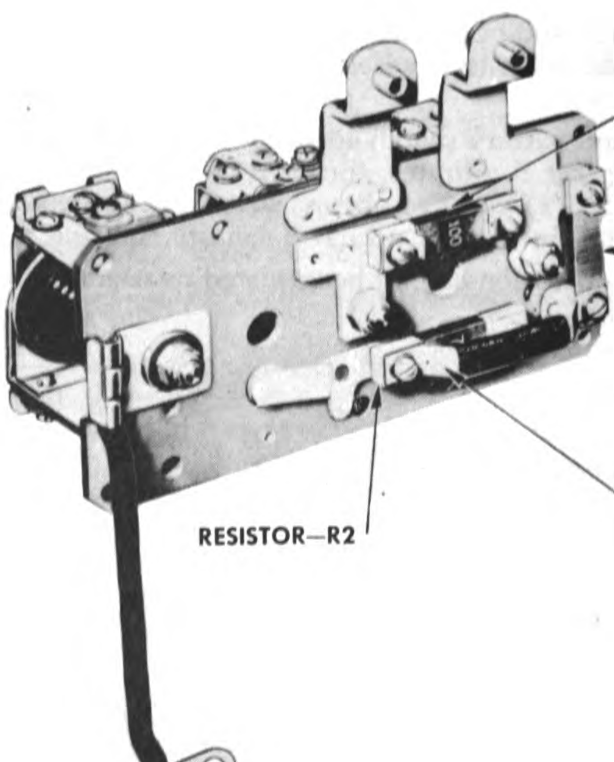
(3) Take out six screws holding sub-base to base. Four of these screws are at corners and two are ground connections, near edge, on spring side of units.

(4) Lift sub-base from regulator base.

e. Remove Filter (VAD type only). Take out bracket screws and disconnect terminal post connector.



VAC, VAL, VAM, VRA, VRG, VRH AND VRY TYPE REGULATORS



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VAD TYPE REGULATORS

Figure 94—Resistor Assembly on Group 4 Regulators

56. CLEANING OF COMPONENTS.

a. **Studs, Screws, and Loose Metal Parts.** Soak in dry-cleaning solvent and clean and dry thoroughly.

b. **Assemblies, Insulation, Condensers, and Resistors.** Wipe with clean rag slightly dampened in dry-cleaning solvent. Blow off with clean, dry, low pressure air. Do not bend or damage parts.

57. INSPECTION AND TEST OF COMPONENTS.

a. **Visual Inspection.** Inspect regulator parts thoroughly (par. 54 **b**).

b. **Resistance Tests.**

(1) RESISTORS. Remove resistors one at a time and check on ohmmeter (ST-284). Replace any that are cracked or are not within limits (par. 61 **a**) Make sure resistors are correctly installed as any interchanging would make regulator inoperative. See figure 94 for correct resistor assembly.

(2) CUT-OUT RELAY SHUNT COIL. With ohmmeter measure resistance from ground lead to cut-out relay stationary contact. This ground lead was fastened to base between cut-out relay and current regulator units. Install new cut-out relay unit (par. 58 **a**) if resistance is not within specifications (par. 61 **a**).

(3) VOLTAGE REGULATOR WINDING. With ohmmeter measure resistance between two coil leads. One of these leads was connected to ground between voltage and current regulator units. Other lead is connected to resistor through base next to ground connection. It is unnecessary to remove this connection to check resistance. Do not interchange these leads when reconnecting. Install new voltage regulator unit (par. 58 **c**) if resistance is not within specifications (par. 61 **a**).

(4) CURRENT REGULATOR FREQUENCY WINDING (if pertinent). This is the winding of fine wire on the center unit. Remove connection to base between current and voltage regulator units and measure from this lead to current regulator yoke. Install new current regulator unit (par. 58 **b**) if this resistance is not within limits (par. 61 **a**).

(5) VOLTAGE REGULATOR FREQUENCY WINDING (VAD type only). Place paper between voltage regulator contacts and measure resistance from Arm terminal to current regulator yoke. Install new voltage regulator unit (par. 58 **c**) if resistance is not within specifications (par. 61 **a**).

c. **Continuity Tests.**

(1) Make sure all resistors are correctly assembled (fig. 94).

(2) With test probes touch Arm terminal and circuit breaker stationary contact. If lamp does not light it indicates an open circuit in one of the series coils or connections. Inspect to find cause of open and repair or replace parts affected (par. 58).

(3) Touch test probes to Arm and Bat terminals. If lamp lights install new cut-out relay unit (par. 58 **a**). Hold cut-out relay contacts

closed. If lamp does not light install new cut-out relay contacts (par. 58 d) or complete cut-out relay unit (par. 58 a).

(4) Touch test probes to Field and Arm terminals. If lamp does not light it indicates faulty resistor, frequency winding or faulty contacts on either current or voltage regulator units. If lamp lights open current regulator contacts. Release current regulator contacts and open voltage regulator contacts. If lamp does not go out in each case replace armature affected (par. 58 e).

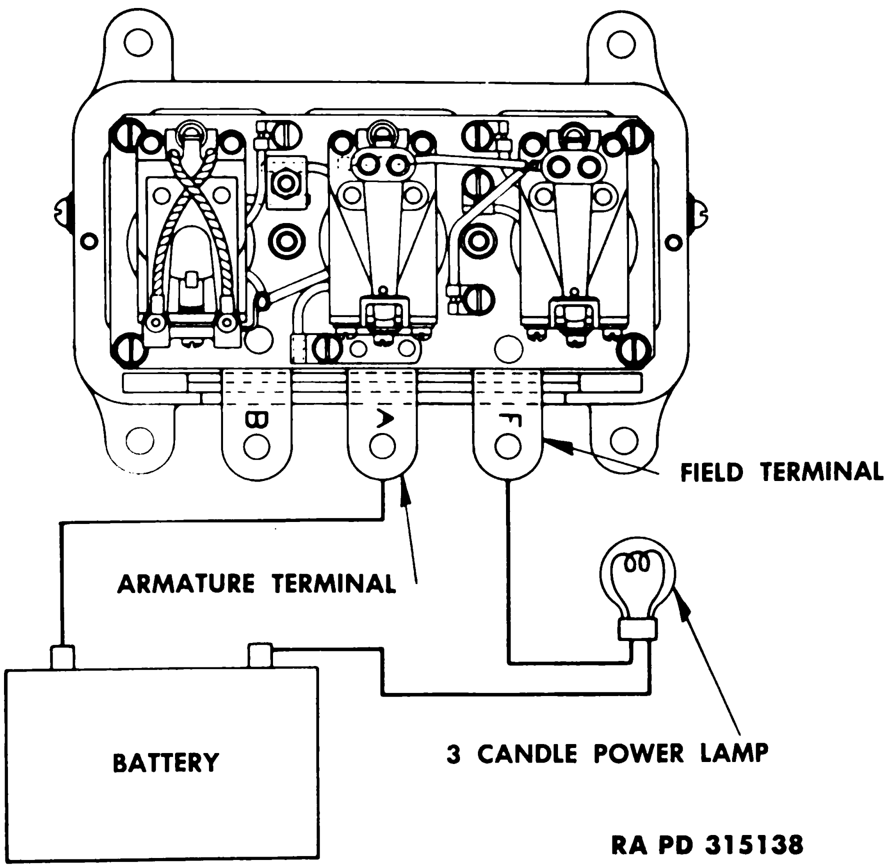


Figure 95—Hookup for Measuring Contact Pressure and Armature Air Gap on Voltage and Current-regulator Units—Group 4 Regulators

d. **Condenser Tests** (if pertinent). Disconnect condenser leads and measure capacity with condenser tester. It is unnecessary to dismount condenser. Install new condenser if capacity is not within specifications (par. 61 a). Check condensers for grounds and replace if grounded.

e. **Contact Pressure Tests.**

(1) Back off adjusting nut on voltage and current regulator units until there is no spring tension.

(2) Place sub-base on insulated table and connect battery and lamp bulb in series with Arm and Field terminals (fig. 95). Remove

REGULATORS—GROUP 4

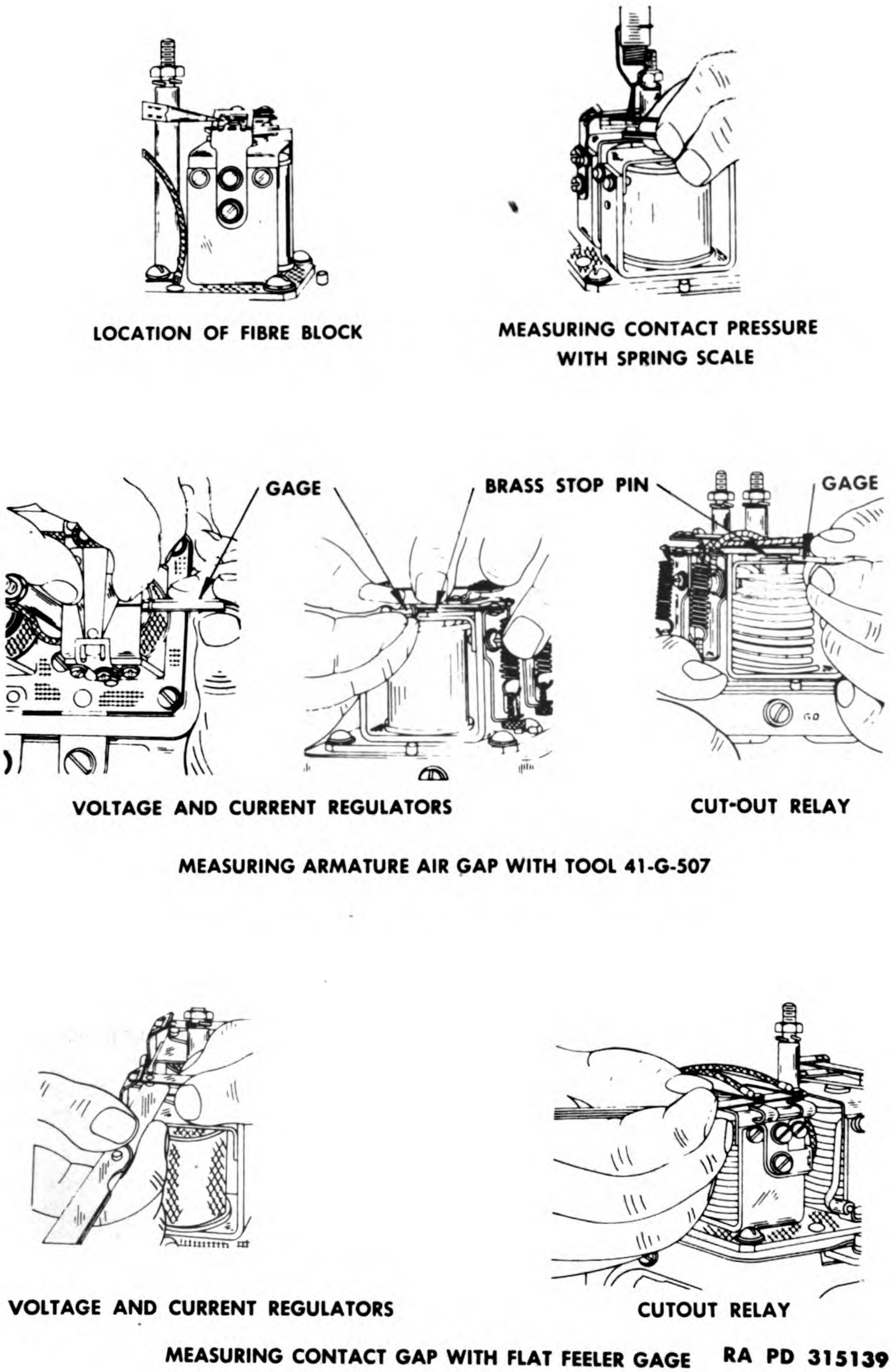


Figure 96—Adjustments of Group 4 Regulators

contact spring stop on VR and CR units. Hook spring scale at upper contact. Hold armature firm and pull contacts apart with scale (fig. 96). Take reading just as lamp goes out. Install new armature (par. 58 e) if this reading is not between seven and eight ounces. Check both current and voltage regulator units in this manner.

(3) Install armature stop making sure fiber bumper block (fig. 96) is in place.

f. **Filter Tests** (VAD only).

(1) With direct current test probes touch either filter terminal and filter case. Replace if lamp lights.

(2) Touch probes to two filter terminals. Replace filter if the lamp does not light.

58. REPAIR AND REBUILDING OF COMPONENTS.

a. **To Install New Cut-out Relay Unit.**

(1) Remove nut and clamp on series connection between circuit breaker and current regulator units.

(2) Remove nut and washer from bottom of magnet core.

(3) Lift circuit breaker unit off base.

(4) Install new circuit breaker unit on base. Make sure alining lug enters hole in base.

(5) On VAD-type install lead on core.

(6) Install and tighten the core washer and nut.

(7) Install and tighten series clamp, lock washer, and nut.

b. **To Install New Current Regulator Unit.**

(1) Remove nut and clamp on series connection. (2 connections on VAD 4106B.)

(2) Unsolder lead from contact spring and disconnect frequency winding leads from base and yoke. Disconnect series connection where is connects to Arm terminal through base.

(3) Disconnect voltage regulator frequency winding from current regulator yoke on VAD type.

(4) Remove nut and washer from bottom of core. Lift off current regulator unit.

(5) Install new current regulator unit on base and turn so alining lug enters hole.

(6) Install and tighten core nut and lock washer.

(7) Install and tighten series connections.

(8) Install and tighten frequency connections.

(9) Solder contact lead to contact spring.

c. **To Install New Voltage Regulator Unit.**

(1) Unsolder lead from contact spring.

(2) Disconnect main winding where it is connected to base.

(3) On VAD type disconnect frequency winding leads where they are connected to base and to current regulator.

(4) On VAD 4106B remove nut and clamp from series connection between voltage and current regulator units. Remove other series connection from base.

(5) Remove nut and lock washer from core. Lift unit from base.

(6) Install new unit on base and turn so alining lug enters hole in base.

(7) Install and tighten lock washer and core nut.

(8) Connect main winding lead to base. One lead is a ground lead and will be connected during regulator assembly (par. 59).

(9) Solder lead to contact spring.

(10) On VAD type connect frequency winding leads to current regulator yoke and to armature terminal through base. Connect series winding to armature terminal at same time.

(11) On VAD 4106B install series clamp, lock washer, and nut.

d. To Install New Cut-out Relay Contacts. (Does not apply to VAD type as they are complete unit replacement only.)

(1) Remove armature spring, adjusting nut and screw.

(2) Remove screws holding armature to yoke. Lift off armature.

(3) Unsolder and unclamp series and shunt coil connections from stationary contact.

(4) Take out stationary contact screws. Lift off contact and insulation.

(5) Install insulation, new contact, insulating bushings, insulating washers, plain washers, lock washers and screws and tighten.

(6) Clamp series and shunt coil leads to contact bracket and solder.

(7) Place armature on yoke and install attaching screws, lock washers, and plain washers. Hold armature hinge tightly against yoke while tightening screws.

(8) Install armature spring, adjusting screw, and adjusting nut.

(9) Measure gap between armature hinge or hinge spacer and yoke. If this gap is more than 0.002 inch loosen armature screws and press armature against yoke. Tighten screws and check gap.

e. To Install New Voltage or Current Regulator Armature. (Does not apply to VAD type as they are complete unit replacement only.)

(1) Remove adjusting nut, adjusting screw, and armature spring. Unsolder lead from contact spring.

(2) Remove screws holding armature to yoke. Lift off armature.

(3) Place new armature on yoke. Install plain washers, lock washers, and screws. Hold armature hinge tightly against yoke when tightening screws.

(4) Assemble armature spring, adjusting screw and adjusting nut. Solder lead to contact spring with rosin core solder.

(5) Measure gap between armature hinge or hinge spacer and yoke. If this gap is more than 0.002 inch loosen armature screws and press armature against yoke. Tighten screws and check gap.

59. ASSEMBLY.

a. Tighten Screws. Tighten all screws and nuts and install lock wire where required.

b. Assemble Sub-base to Base.

(1) On VAD type, thread three leads through holes in sub-base.

(2) Install four screws and lock washers at corners. On VAD 4106B connect circuit breaker and voltage regulator ground leads to two of these screws.

(3) Install two ground screws between units on spring side. Connect circuit breaker and voltage regulator ground leads to these screws.

(4) On VAD-type connect lead from radio type resistor and condenser to voltage regulator yoke and connect lead from automotive type condenser to current regulator yoke.

(5) On VAD-type regulators install filter and terminal stud connector in base. Connect lead from cut-out relay core to "in" terminal of filter. Install bottom plate on regulator.

60. TESTS AND ADJUSTMENTS.

a. Adjust Armature Air Gap.

(1) CUT-OUT RELAY UNIT. Use pin gage of correct limits (par. 61 a) and insert between armature and core on contact side and next to brass pin in core (fig. 96). Adjust gap by bending armature stop. Be sure stop does not interfere with armature movement.

(2) VOLTAGE-REGULATOR UNIT. Connect battery and lamp in series with Arm and Field terminals to indicate when contacts are opened and closed (fig. 95). Insert pin gage of correct dimension (par. 61 a) between armature and core on contact side and next to brass pin in core (fig. 96). Hold armature down with two fingers (fig. 96) so contact spring is not touched. Adjust gap so lamp will burn brightly when high limit gage is in place and will go out or dim when low limit gage is in place. Adjust gap by slightly loosening screws holding armature stop and raising or lowering stop. Tighten screws and check gap.

(3) CURRENT-REGULATOR UNIT. Check and adjust as described above for voltage regulator using correct gage (par. 61 a).

b. Check Gap Between Contact Spring and Stop.

(1) VOLTAGE-REGULATOR UNIT. Hold armature down against core stop and with feeler gage measure gap between contact spring and armature stop. If gap is not between 0.010 and 0.016 inch inspect bumper block (fig. 96) for damage or improper assembly and inspect armature stop for distortion or incorrect adjustment.

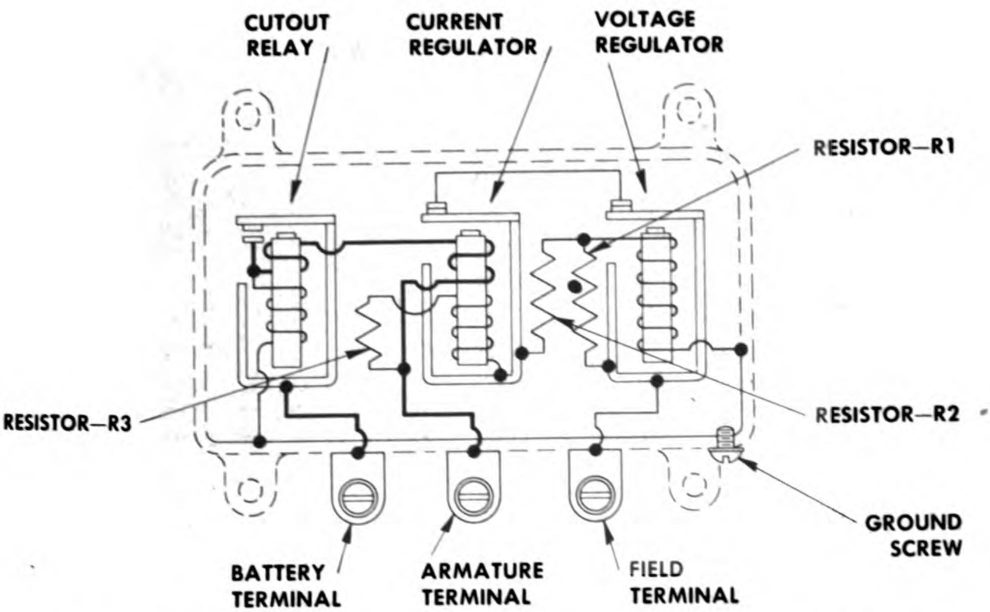
(2) CURRENT-REGULATOR UNIT. The same limits and procedure as described for voltage regulator applies to current regulator unit.

c. Measure Contact Point Gap on Cut-out Relay Unit. Measure gap between both sets of contacts (fig. 96). Do not set this gap to less than 0.025 inch (0.080 inch for VAD type) but it may be set larger than this after adjusting contact opening amperage. Bend stationary contact brackets to adjust gap and aline contacts so contact is made and broken on both sets of contacts at the same time.

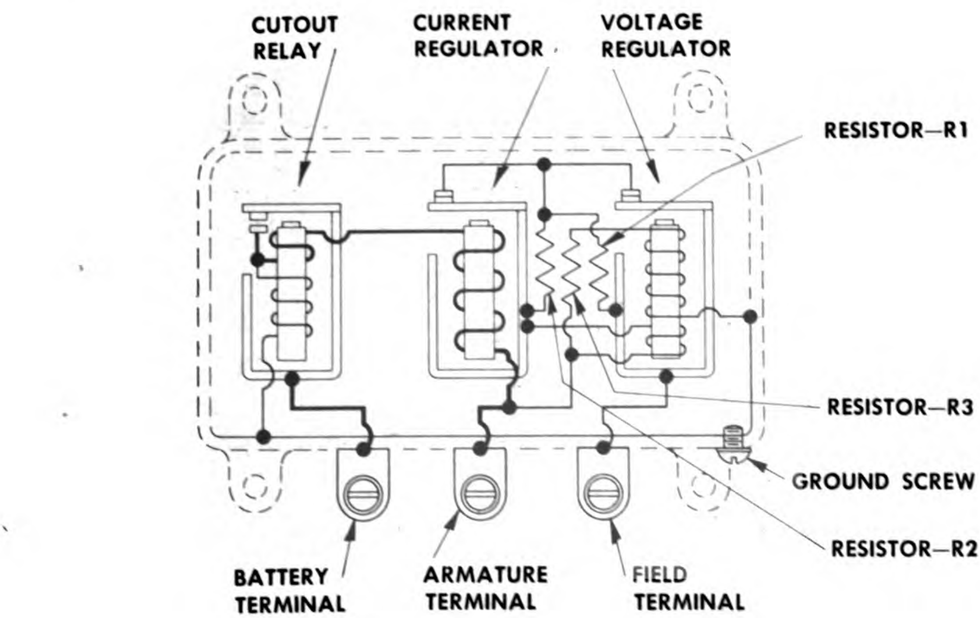
d. Check Internal Wiring Connections. Refer to internal wiring diagram specified (par. 61 a) for regulator and check internal wiring.

e. Adjust Electrical Settings (par. 54 c).

REGULATORS—GROUP 4



VAC-4001A, VRA-4102A, VRA-4105A, VRG-4102B AND VRG-4103C REGULATORS



VAL-4101A REGULATOR

RA PD 315067

Figure 97—Internal Wiring Diagrams of VAC, VAL, VRA, and VRG-type Regulators

61. FITS, TOLERANCES, AND SPECIFICATIONS.

a. Tabulated Specifications.

	VAC 4001A	VAD 4103A	VAD 4105A	VAD 4106A	VAD 4106B
Rated Volts	12	24	24	24	24
Ground Polarity	Positive	Negative	Negative	Negative	Negative
Resistors (fig. 94)	3 used	4 used	4 used	4 used	4 used
R1 marked	100	135	135	135	135
R1 ohms	95–105	130–140	130–140	130–140	130–140
R2 marked	15	70	70	70	70
R2 ohms	13.5–16.5	68–72	68–72	68–72	68–72
R3 marked	65	100	100	100	100
R3 ohms	0.6–0.7	95–105	95–105	95–105	95–105
R4 marked	....	....	....	....	......
R4 ohms	....	95–105	95–105	95–105	95–105
Condensers	None	2 used	2 used	2 used	2 used
C1 (Automotive type) microfarads	....	0.15–0.19	0.15–0.19	0.15–0.19	0.15–0.19
C2 (Radio type) microfarads	....	0.006	0.006	0.006	0.006
Internal Wiring	Fig. 97	Fig. 98	Fig. 98	Fig. 98	Fig. 98
Circuit Breaker Unit					
Resistance of coil (ohms)	47.5–52.5	98–108	98–108	231–255	231–255
Armature air gap (inches)	0.0595–0.0625	0.095–0.100	0.095–0.100	0.095–0.100	0.095–0.100
Contact point gap (inches)	0.025 min	0.095–0.100	0.095–0.100	0.080–0.130	0.080–0.130
Armature spring (number of coils)	16	16	16	16	16
Contacts close (volts)	13.0–13.5	25.7–26.7	25.7–26.7	25.7–26.7	25.7–26.7
Contacts open (amps discharge)	0.5–6.0	16–21	16–21	16–21	16–21

	VAC 4001A	VAD 4103A	VAD 4105A	VAD 4106A	VAD 4106B
Voltage Regulator Unit					
Resistance of winding (ohms)	15.7–17.3	63.6–70.4	63.6–70.4	63.6–70.4	63.6–70.4
Resistance of freq winding (ohms)	None	0.065–0.071	0.065–0.071	0.060–0.066	0.060–0.066
Armature air gap (inches)	0.040–0.042	0.040–0.042	0.040–0.042	0.040–0.042	0.040–0.042
Armature spring (number of coils)	14½	14½	14½	14½	14½
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating voltages					
50° F.	14.31 ±0.25	28.58 ±0.40	28.58 ±0.40	28.58 ±0.40	28.58 ±0.40
60° F.	14.28 ±0.25	28.54 ±0.40	28.54 ±0.40	28.54 ±0.40	28.54 ±0.40
70° F.	14.25 ±0.25	28.50 ±0.40	28.50 ±0.40	28.50 ±0.40	28.50 ±0.40
80° F.	14.22 ±0.25	28.46 ±0.40	28.46 ±0.40	28.46 ±0.40	28.46 ±0.40
90° F.	14.19 ±0.25	28.41 ±0.40	28.41 ±0.40	28.41 ±0.40	28.41 ±0.40
100° F.	14.16 ±0.25	28.37 ±0.40	28.37 ±0.40	28.37 ±0.40	28.37 ±0.40
110° F.	14.13 ±0.25	28.33 ±0.40	28.33 ±0.40	28.33 ±0.40	28.33 ±0.40
120° F.	14.10 ±0.25	28.29 ±0.40	28.29 ±0.40	28.29 ±0.40	28.29 ±0.40
Current Regulator Unit					
Resistance of freq winding (ohms)	0.094–0.104	None	None	None	None
Armature air gap (inches)	0.047–0.049	0.047–0.049	0.047–0.049	0.047–0.049	0.047–0.049
Armature spring (number of coils)	16	16	16	16	16
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating amperage	29.0–31.0	50.0–53.0	50.0–53.0	50.0–53.0	50.0–53.0

	VAL 4101A	VAM 4101A	VRA 4102A	VRA 4105A	VRG 4102B
Rated Volts	24	12	12	12	12
Ground Polarity	Negative	Negative	Positive	Negative	Positive
Resistors (fig. 94)	3 used	4 used	3 used	3 used	3 used
R1 marked	135	80	135	135	135
R1 ohms	130–140	76–84	130–140	130–140	130–140
R2 marked	60	15	15	15	15
R2 ohms	57–63	13.5–16.5	13.5–16.5	13.5–16.5	13.5–16.5
R3 marked	70	20	0.65	0.65	0.65
R3 ohms	68–72	19–21	0.6–0.7	0.6–0.7	0.6–0.7
R4 marked	....	1	....	....	....
R4 ohms	....	0.9–1.1	....	....	....
Condensers	None	None	None	None	None
C1 (Automotive type) microfarads	....	....	....	....	....
C2 (Radio type) microfarads	....	....	....	....	....
Internal Wiring	Fig. 97	Fig. 99	Fig. 97	Fig. 97	Fig. 97
Circuit Breaker Unit					
Resistance of coil (ohms)	215–237	43.7–48.3	47.5–52.5	47.5–52.5	47.5–52.5
Armature air gap (inches)	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625
Contact point gap (inches)	0.025 min	0.025 min	0.025 min	0.025 min	0.025 min
Armature spring (number of coils)	16	16	16	16	16
Contacts close (volts)	26.0–27.2	13.0–13.5	13.0–13.5	13.0–13.5	13.0–13.5
Contacts open (amps discharge)	3.0–5.0	0.5–6.0	0.5–6.0	0.5–6.0	0.5–6.0

REGULATORS—GROUP 4

	VAL 4101A	VAM 4101A	VRA 4102A	VRA 4105A	VRG 4102B
Voltage Regulator Unit					
Resistance of winding (ohms)	63.6–70.4	15.7–17.3	15.7–17.3	15.7–17.3	15.7–17.3
Resistance of freq winding (ohms)	0.060–0.066	None	None	None	None
Armature air gap (inches)	0.040–0.042	0.040–0.042	0.040–0.042	0.040–0.042	0.040–0.042
Armature spring (number of coils)	14½	14½	14½	14½	14½
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating voltages					
50° F.	29.38 ±0.40	14.31 ±0.25	14.31 ±0.25	14.31 ±0.25	14.31 ±0.25
60° F.	29.34 ±0.40	14.28 ±0.25	14.28 ±0.25	14.28 ±0.25	14.28 ±0.25
70° F.	29.30 ±0.40	14.25 ±0.25	14.25 ±0.25	14.25 ±0.25	14.25 ±0.25
80° F.	29.26 ±0.40	14.22 ±0.25	14.22 ±0.25	14.22 ±0.25	14.22 ±0.25
90° F.	29.21 ±0.40	14.19 ±0.25	14.19 ±0.25	14.19 ±0.25	14.19 ±0.25
100° F.	29.17 ±0.40	14.16 ±0.25	14.16 ±0.25	14.16 ±0.25	14.16 ±0.25
110° F.	29.13 ±0.40	14.13 ±0.25	14.13 ±0.25	14.13 ±0.25	14.13 ±0.25
120° F.	29.09 ±0.40	14.10 ±0.25	14.10 ±0.25	14.10 ±0.25	14.10 ±0.25
Current Regulator Unit					
Resistance of freq winding (ohms)	None	....	0.094–0.104	0.094–0.104	0.129–0.143
Armature air gap (inches)	0.047–0.049	0.047–0.049	0.047–0.049	0.047–0.049	0.047–0.049
Armature spring (number of coils)	16	16	16	16	16
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating amperage	25.0–27.0	39.0–41.0	39.0–41.0	39.0–41.0	25.0–27.0

	VRG 4103C	VRH 4101C	VRH 4102A	VRH 4104A-1
Rated Volts	12	12	12	12
Ground Polarity	Negative	Pos or Neg	Pos or Neg	Pos or Neg
Resistors (fig. 94)	3 used	4 used	4 used	4 used
R1 marked	135	80	80	80
R1 ohms	130–140	76–84	76–84	76–84
R2 marked	15	15	15	15
R2 ohms	13.5–16.5	13.5–16.5	13.5–16.5	13.5–16.5
R3 marked	0.65	30	30	30
R3 ohms	0.6–0.7	28–32	28–32	28–32
R4 marked	....	1	1	1
R4 ohms	....	0.9–1.1	0.9–1.1	0.9–1.1
Condensers	None	None	None	1 used
C1 (Automotive type) microfarads	....	....	....	0.15–0.19
C2 (Radio type) microfarads	....	....	....	....
Internal Wiring	Fig. 97	Fig. 99	Fig. 99	Fig. 99
Circuit Breaker Unit				
Resistance of coil (ohms)	47.5–52.5	47.5–52.5	47.5–52.5	47.5–52.5
Armature air gap (inches)	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625
Contact point gap (inches)	0.025 min	0.025 min	0.025 min	0.025 min
Armature spring (number of coils)	16	16	16	16
Contacts close (volts)	13.0–13.5	13.0–13.5	13.0–13.5	13.0–13.5
Contacts open (amperes discharge)	0.5–6.0	0.5–6.0	0.5–6.0	0.5–6.0

REGULATORS—GROUP 4

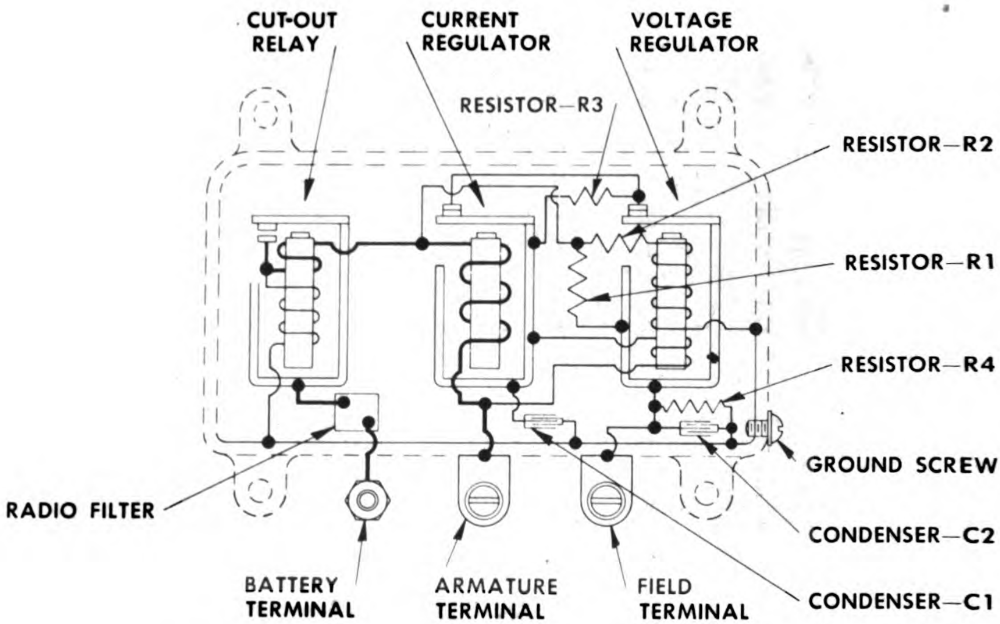
	VRG 4103C	VRH 4101C	VRH 4102A	VRH 4104A-1
Voltage Regulator Unit				
Resistance of winding (ohms)	15.7–17.3	15.7–17.3	15.7–17.3	15.7–17.3
Resistance of freq winding (ohms)	None	None	None	None
Armature air gap (inches)	0.040–0.042	0.040–0.042	0.040–0.042	0.040–0.042
Armature spring (number of coils)	14½	14½	14½	14½
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating voltages				
50° F.	14.31 ±0.25	14.31 ±0.25	14.31 ±0.25	14.31 ±0.25
60° F.	14.28 ±0.25	14.28 ±0.25	14.28 ±0.25	14.28 ±0.25
70° F.	14.25 ±0.25	14.25 ±0.25	14.25 ±0.25	14.25 ±0.25
80° F.	14.22 ±0.25	14.22 ±0.25	14.22 ±0.25	14.22 ±0.25
90° F.	14.19 ±0.25	14.19 ±0.25	14.19 ±0.25	14.19 ±0.25
100° F.	14.16 ±0.25	14.16 ±0.25	14.16 ±0.25	14.16 ±0.25
110° F.	14.13 ±0.25	14.13 ±0.25	14.13 ±0.25	14.13 ±0.25
120° F.	14.10 ±0.25	14.10 ±0.25	14.10 ±0.25	14.10 ±0.25
Current Regulator Unit				
Resistance of freq winding (ohms)	0.129–0.143	None	None	None
Armature air gap (inches)	0.047–0.049	0.047–0.049	0.047–0.049	0.047–0.049
Armature spring (number of coils)	16	16	16	16
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating amperage	34.0–36.0	49.0–51.0	54.0–56.0	54.0–56.0

	VRH 4104B-1	VRH 4104C-1	VRH 4105A	VRH 4106A
Rated Volts	12	12	12	12
Ground Polarity	Pos or Neg	Pos or Neg	Pos or Neg	Pos or Neg
Resistors (fig. 94)	4 used	4 used	4 used	4 used
R1 marked	80	80	80	80
R1 ohms	76–84	76–84	76–84	76–84
R2 marked	15	15	15	15
R2 ohms	13.5–16.5	13.5–16.5	13.5–16.5	13.5–16.5
R3 marked	30	30	30	30
R3 ohms	28–32	28–32	28–32	28–32
R4 marked	1	1	1	1
R4 ohms	0.9–1.1	0.9–1.1	0.9–1.1	0.9–1.1
Condensers	1 used	1 used	None	None
C1 (Automotive type) microfarads	0.15–0.19	0.15–0.19	....	....
C2 (Radio type) microfarads	....	....	....	....
Internal Wiring	Fig. 99	Fig. 99	Fig. 99	Fig. 99
Circuit Breaker Unit				
Resistance of coil (ohms)	47.5–52.5	47.5–52.5	47.5–52.5	47.5–52.5
Armature air gap (inches)	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625
Contact point gap (inches)	0.025 min	0.025 min	0.025 min	0.025 min
Armature spring (number of coils)	16	16	16	16
Contacts close (volts)	13.0–13.5	13.0–13.5	13.0–13.5	13.0–13.5
Contacts open (amperes discharge)	0.5–6.0	0.5–6.0	0.5–6.0	0.5–6.0

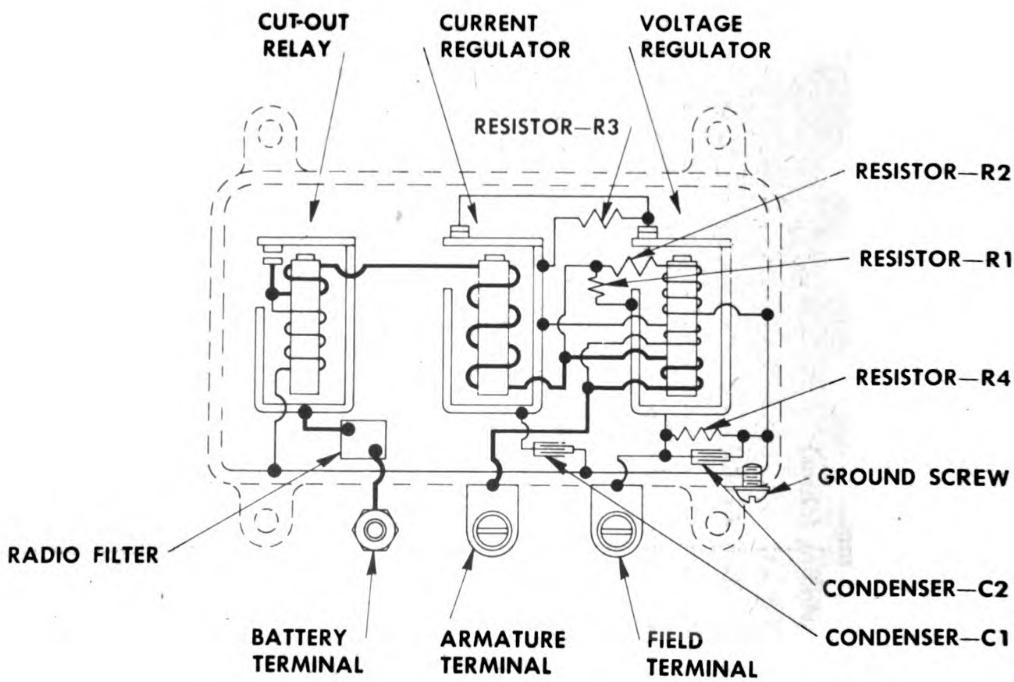
	VRH 4104B-1	VRH 4104C-1	VRH 4105A	VRH 4106A
Voltage Regulator Unit				
Resistance of winding (ohms)	15.7–17.3	15.7–17.3	15.7–17.3	15.7–17.3
Resistance of freq winding (ohms)	None	None	None	None
Armature air gap (inches)	0.040–0.042	0.040–0.042	0.040–0.042	0.040–0.042
Armature spring (number of coils)	14½	14½	14½	14½
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating voltages				
50° F.	14.56 ±0.25	14.31 ±0.25	14.31 ±0.25	14.31 ±0.25
60° F.	14.53 ±0.25	14.28 ±0.25	14.28 ±0.25	14.28 ±0.25
70° F.	14.50 ±0.25	14.25 ±0.25	14.25 ±0.25	14.25 ±0.25
80° F.	14.47 ±0.25	14.22 ±0.25	14.22 ±0.25	14.22 ±0.25
90° F.	14.44 ±0.25	14.19 ±0.25	14.19 ±0.25	14.19 ±0.25
100° F.	14.41 ±0.25	14.16 ±0.25	14.16 ±0.25	14.16 ±0.25
110° F.	14.38 ±0.25	14.13 ±0.25	14.13 ±0.25	14.13 ±0.25
120° F.	14.35 ±0.25	14.10 ±0.25	14.10 ±0.25	14.10 ±0.25
Current Regulator Unit				
Resistance of freq winding (ohms)	None	None	None	None
Armature air gap (inches)	0.047–0.049	0.047–0.049	0.047–0.049	0.047–0.049
Armature spring (number of coils)	16	16	16	16
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating amperage	54.0–56.0	54.0–56.0	49.0–51.0	54.0–56.0

	VRY 4201A	VRY 4201B	VRY 4203A	VRY 4203B
Rated Volts	6	6	6	6
Ground Polarity	Positive	Positive	Negative	Negative
Resistors (fig. 94)	3 used	3 used	3 used	3 used
R1 marked	80	80	80	80
R1 ohms	76–84	76–84	76–84	76–84
R2 marked	7	7	7	7
R2 ohms	6.5–7.5	6.5–7.5	6.5–7.5	6.5–7.5
R3 marked	80	80	80	80
R3 ohms	76–84	76–84	76–84	76–84
R4 marked	.....	.....	.....	.....
R4 ohms	.....	.....	.....	.....
Condensers	None	None	None	None
C1 (Automotive type) microfarads	.....	.....	.....	.....
C2 (Radio type) microfarads	.....	.....	.....	.....
Internal Wiring	Fig. 100	Fig. 100	Fig. 100	Fig. 100
Circuit Breaker Unit				
Resistance of coil (ohms)	15.8–17.4	15.8–17.4	15.8–17.4	15.8–17.4
Armature air gap (inches)	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625	0.0595–0.0625
Contact point gap (inches)	0.025 min	0.025 min	0.025 min	0.025 min
Armature spring (number of coils)	16	16	16	16
Contacts close (volts)	6.5–7.0†	6.5–7.0†	6.5–7.0†	6.5–7.0†
Contacts open (amperes discharge)	0.5–6.0	0.5–6.0	0.5–6.0	0.5–6.0

	VRY 4201A	VRY 4201B	VRY 4203A	VRY 4203B
Voltage Regulator Unit				
Resistance of winding (ohms)	4.3–4.7	4.3–4.7	4.3–4.7	4.3–4.7
Resistance of freq winding (ohms)	None	None	None	None
Armature air gap (inches)	0.040–0.042	0.040–0.042	0.040–0.042	0.040–0.042
Armature spring (number of coils)	14½	14½	14½	14½
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating voltages				
50° F.	7.41 ±0.15	7.41 ±0.15	7.41 ±0.15	7.41 ±0.15
60° F.	7.38 ±0.15	7.38 ±0.15	7.38 ±0.15	7.38 ±0.15
70° F.	7.35 ±0.15	7.35 ±0.15	7.35 ±0.15	7.35 ±0.15
80° F.	7.32 ±0.15	7.32 ±0.15	7.32 ±0.15	7.32 ±0.15
90° F.	7.29 ±0.15	7.29 ±0.15	7.29 ±0.15	7.29 ±0.15
100° F.	7.26 ±0.15	7.26 ±0.15	7.26 ±0.15	7.26 ±0.15
110° F.	7.23 ±0.15	7.23 ±0.15	7.23 ±0.15	7.23 ±0.15
120° F.	7.20 ±0.15	7.20 ±0.15	7.20 ±0.15	7.20 ±0.15
Current Regulator Unit				
Resistance of freq winding (ohms)	0.033–0.037	0.033–0.037	0.033–0.037	0.033–0.037
Armature air gap (inches)	0.047–0.049	0.047–0.049	0.047–0.049	0.047–0.049
Armature spring (number of coils)	14½	14½	14½	14½
Pressure of contacts (ounces)	7–8	7–8	7–8	7–8
Gap between contact spring and stop	0.010–0.016	0.010–0.016	0.010–0.016	0.010–0.016
Operating amperage	25.0–27.0	32.0–34.0	40.0–42.0	40.0–42.0



VAD-4103A, VAD-4105A AND VAD-4106A REGULATORS

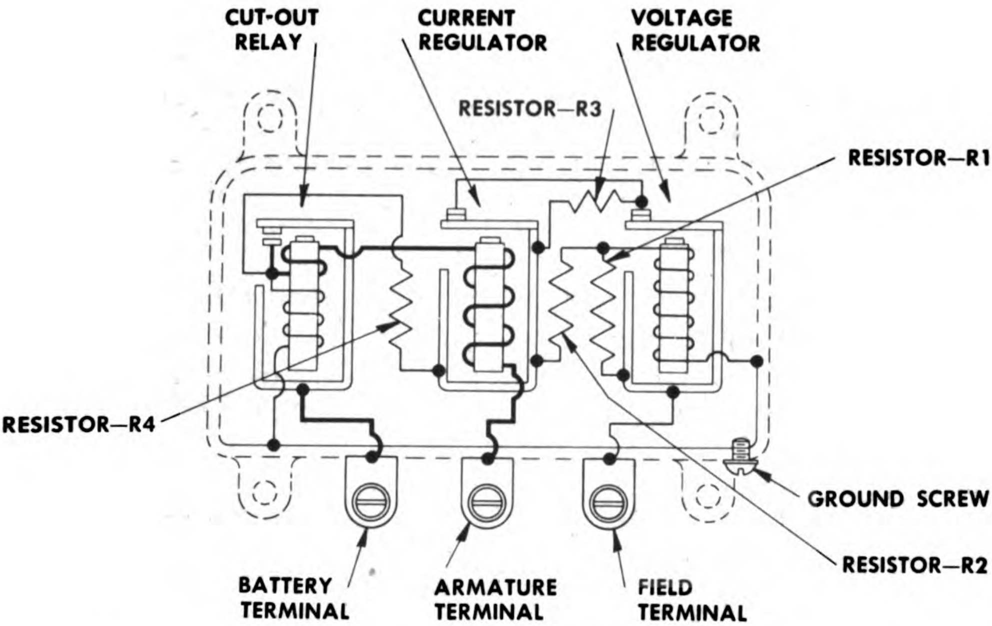


VAD-4106B REGULATOR

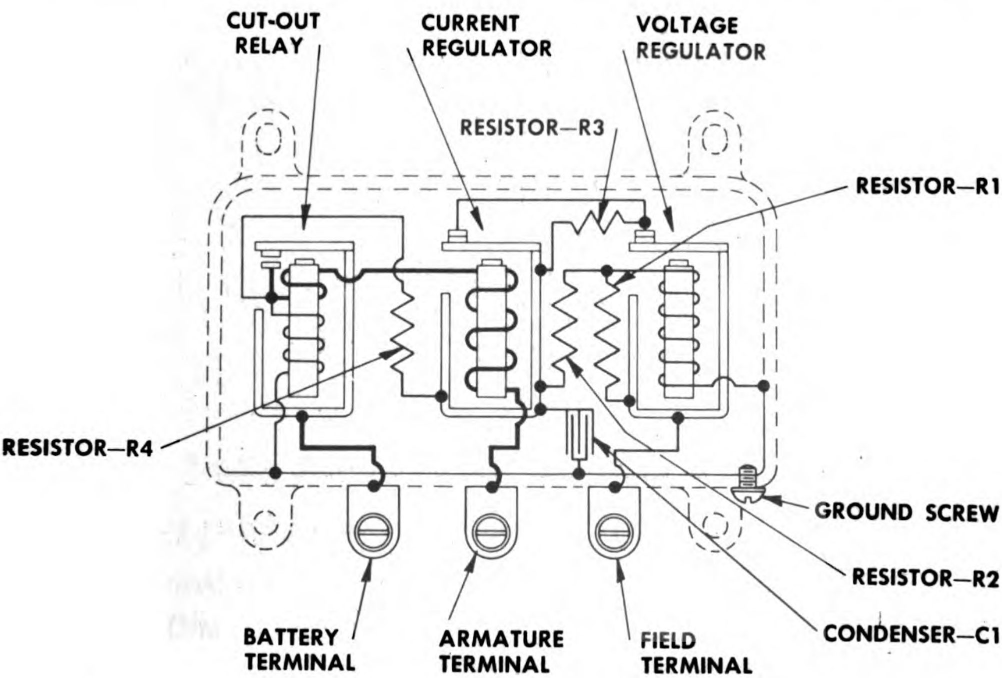
RA PD 315068

Figure 98—Internal Wiring Diagrams of VAD-type Regulators

REGULATORS—GROUP 4



VAM-4101A, VRH-4101C, VRH-4102A, VRH-4105A AND VRH-4106A REGULATORS



VRH-4104A-1, VRH-4104B-1 AND VRH-4104C-1 REGULATORS

RA PD 315069

Figure 99—Internal Wiring Diagrams of VAM- and VRH-type Regulators

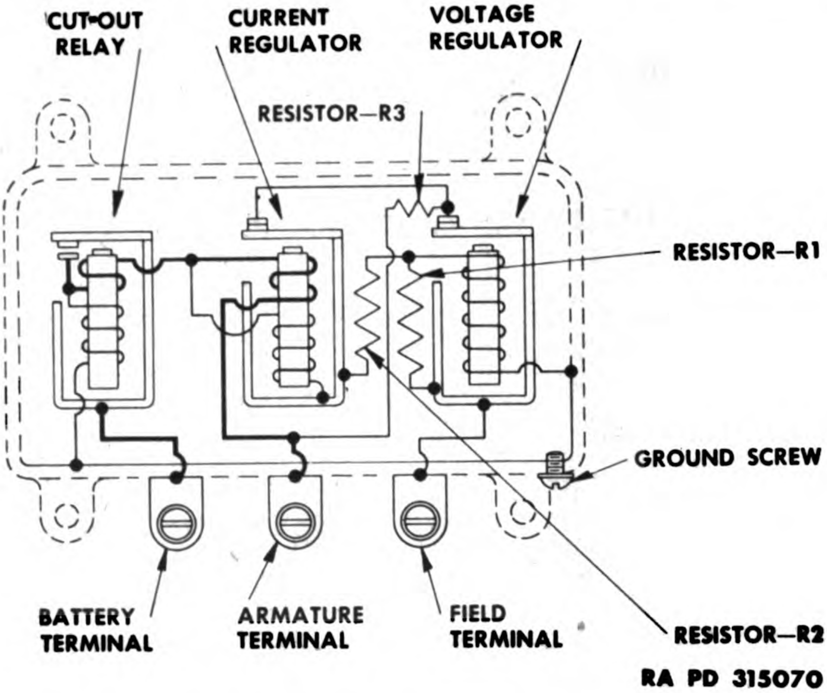


Figure 100—Internal Wiring Diagram of VRY-type Regulators

CHAPTER 4

DISTRIBUTORS

Section I

DISTRIBUTORS—BASIC PRINCIPLES

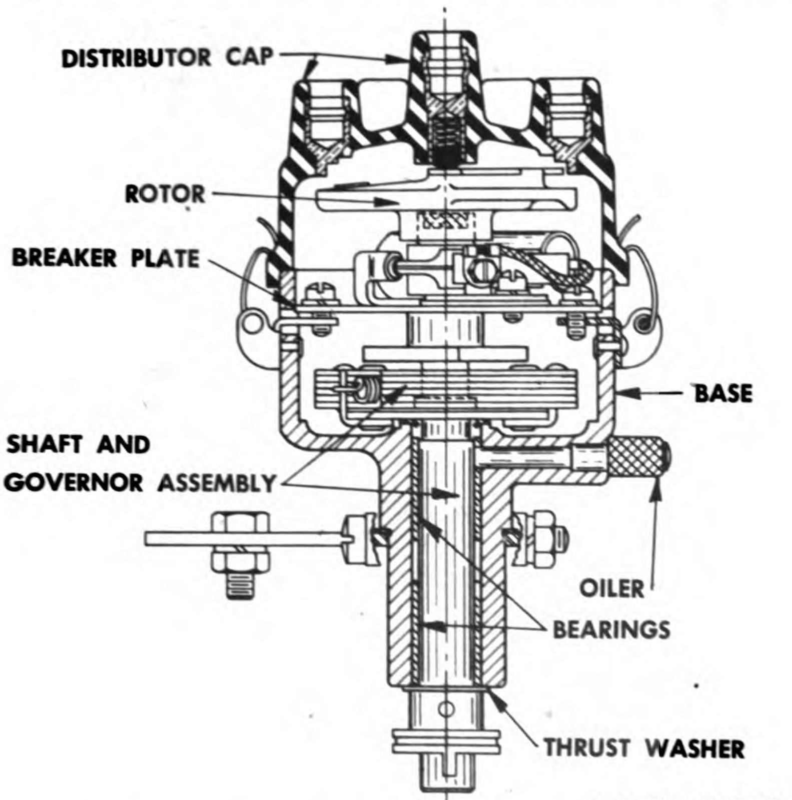


Figure 101—Sectional Drawing of Distributor

62. DESCRIPTION.

a. Construction (fig. 101).

(1) Distributors consist of six main subassemblies or components; these are the cap, rotor, breaker plate, drive shaft, cam and the base. The base is a cast iron housing that supports the other components. Two absorbent bronze bearings in the lower part of the base support the drive shaft. A cam is mounted at the top of the drive shaft usually linked to it by a governor which changes the distributor timing with variations in engine speed. The cam operates the breaker contacts which are mounted on the breaker plate. The breaker contacts are

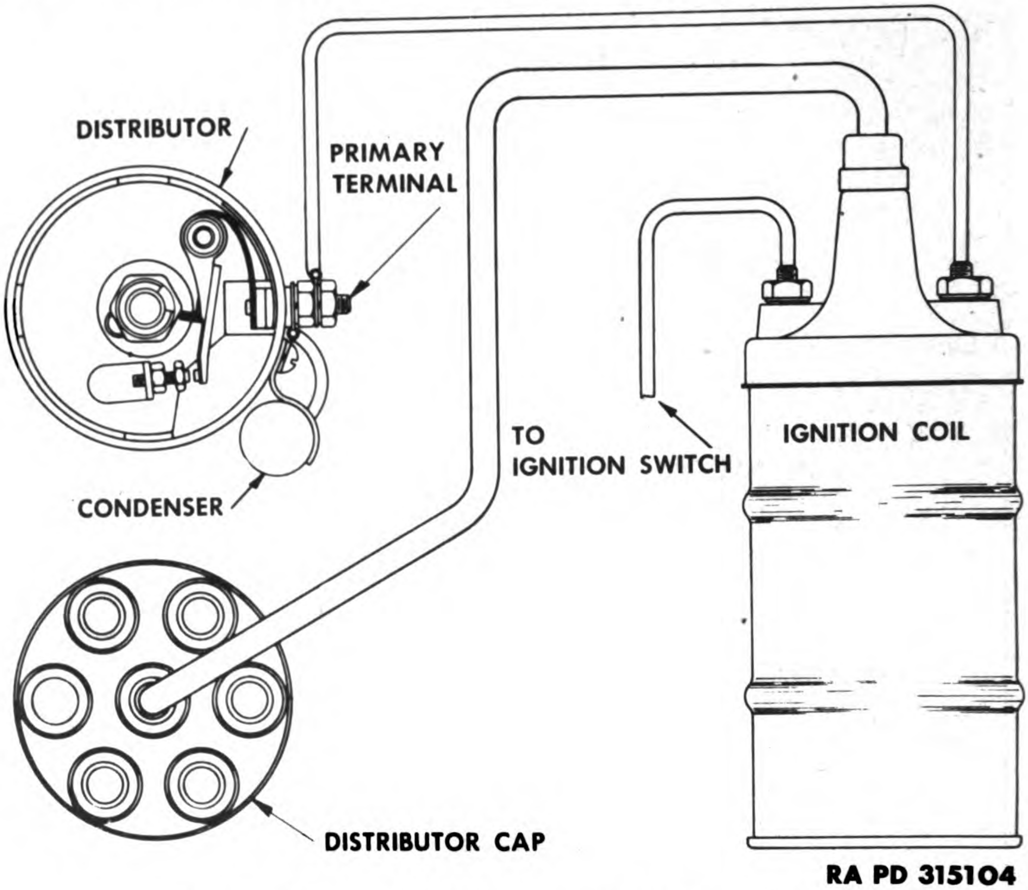


Figure 102—Typical Hookup of Distributor

connected in the ignition coil primary circuit and open at the correct instant to cause a high secondary voltage at the spark plug. The cap has high-tension terminals that are connected to each spark plug. Contacts inside the cap are connected to each of the terminals. The rotor revolves with the drive shaft and contacts each of the cap terminals in the proper order and timing to distribute the high-tension voltage to the correct spark plug.

(2) A condenser is mounted either on the breaker plate or on the outside of the base and is connected across the breaker contacts. The condenser reduces arcing and burning at the contacts and helps to produce a high secondary voltage in the ignition coil.

b. General.

(1) Distributors differ in design of the above parts depending on the number of cylinders and engine requirements. Some distributors are driven by a gear on the lower end of the drive shaft, while others have a tongue that fits a coupling in the engine.

(2) All distributors have a nameplate riveted to the side of the base. On this nameplate is stamped the model number and code date of manufacture. All reference to individual distributors is made by this model number.

63. THEORY AND OPERATION.

a. Theory. The purpose of a distributor is to make and break the ignition coil primary circuit at the correct time, and to distribute the coil secondary voltage to the proper spark plug.

b. Operation.

(1) There are two separate electrical circuits in a distributor (fig. 102). The breaker contacts and condenser are in the primary circuit and carry only low voltage current. The cap and rotor are connected in the secondary circuit and carry the high-voltage spark current.

(2) The centrifugal governor is mounted on the drive shaft and links the cam to the shaft. The governor acts to change the relation of the cam to the shaft as the engine speed is changed. This changes the timing of the spark in relation to the position of the piston in the cylinder.

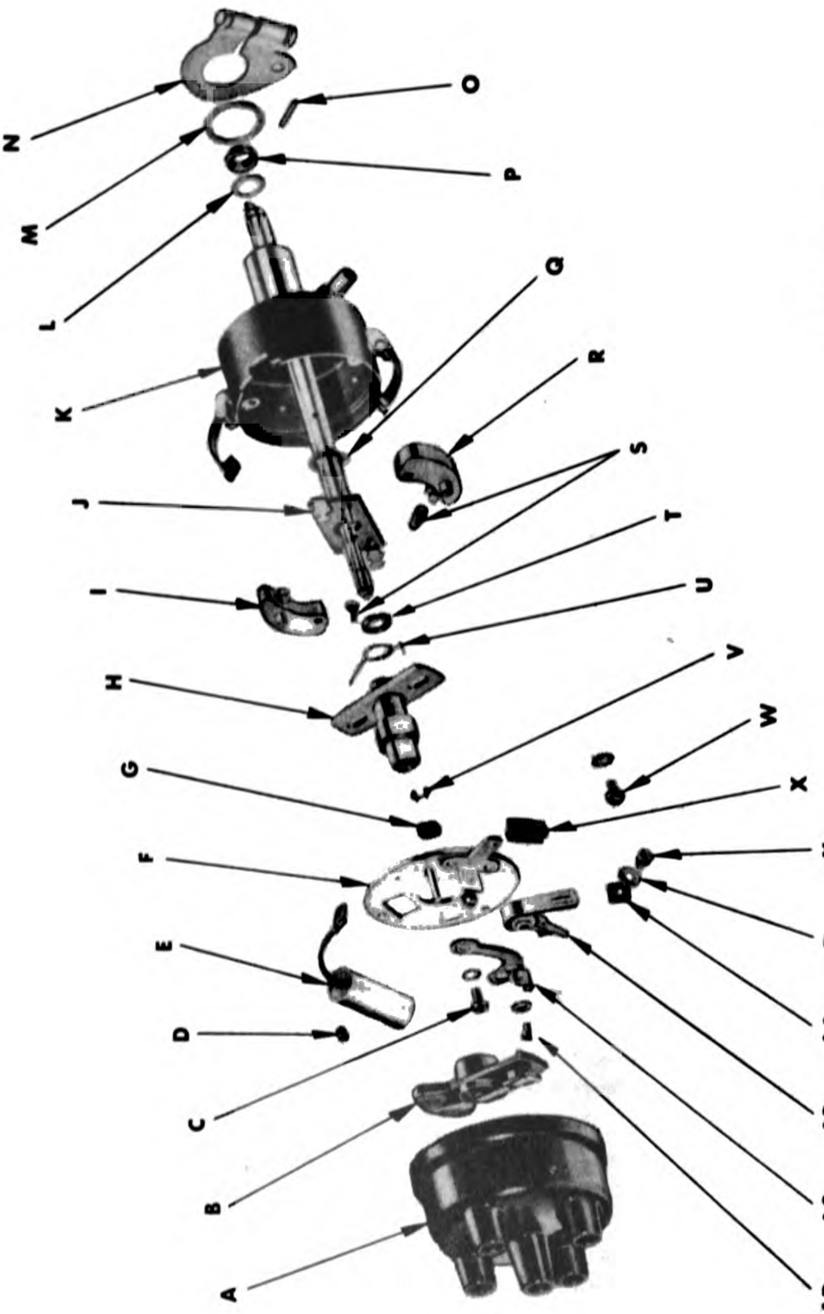


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Figure 103—Components of IGC-type Distributors

CHAPTER 4

DISTRIBUTORS (Cont'd)

Section II

DISTRIBUTORS—GROUP 1

64. DESCRIPTION AND DATA.

a. **Description** (figs. 103 and 104).

(1) Group 1 distributors have automatic governor control of the timing. The IGS and IGT-type distributors also have a vacuum control of the advance. The breaker contacts on the IGS and IGT types are mounted on a subplate which turns on a ball bearing. The vacuum chamber is linked to the subplate by an arm. Changing the amount of vacuum moves the vacuum chamber diaphragm which rotates the subplate thus advancing or retarding the position of the contacts in relation to the cam. The vacuum chamber is connected to the intake

A—CAP
B—ROTOR
C—PLATE MOUNTING SCREW
D—CONDENSER MOUNTING SCREW
E—CONDENSER
F—BREAKER PLATE
G—FELT WICK
H—CAM
I—GOVERNOR WEIGHT
J—DRIVE SHAFT
K—BASE
L—LOWER THRUST WASHER
M—LARGE THRUST WASHER
N—ADVANCE ARM
O—COLLAR RIVET
P—COLLAR
Q—UPPER THRUST WASHER
R—GOVERNOR WEIGHT
S—GOVERNOR WEIGHT SPRING SET
T—CAM SPACER
U—ANTI RATTLE SPRING
V—CAM LOCK SPRING RING
W—TERMINAL SCREW
X—TERMINAL SLOT COVER
Y—BREAKER ARM SPRING SCREW
Z—PLAIN WASHER
AA—BREAKER ARM SPRING CLAMP
AB—BREAKER ARM
AC—BREAKER CONTACT
AD—CONTACT LOCK SCREW

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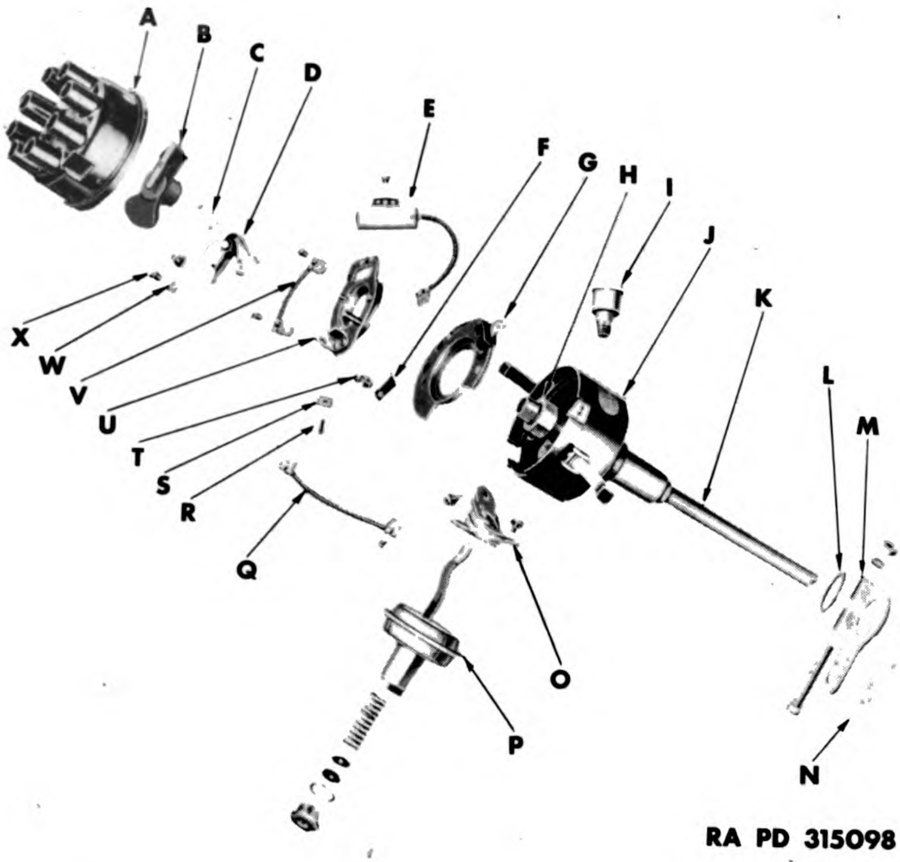
Legend for Figure 103—Components of IGC-type Distributors



A—CAP
B—ROTOR
C—BREAKER CONTACT
D—BREAKER ARM
E—CONDENSER
F—BREAKER PLATE CLAMP
G—BREAKER PLATE
H—CAM
I—GREASE CUP
J—BASE ASSEMBLY
K—SHAFT AND GOVERNOR ASSEMBLY
L—LARGE THRUST WASHER
M—ADVANCE ARM
N—ADVANCE POINTER
O—VACUUM CHAMBER BRACKET
P—VACUUM ADVANCE CHAMBER
Q—PRIMARY LEAD
R—CONTACT ARM SPRING SCREW
S—CONTACT ARM SPRING CLAMP
T—BREAKER PLATE MOUNTING SCREW
U—SUB BREAKER PLATE
V—GROUND LEAD
W—PLAIN WASHER
X—CONTACT LOCK SCREW

RA PD 315098B

Figure 104—Components of IGS-type Distributors

manifold by a tube and thus special engine conditions change the timing to suit the driving conditions. When accelerating or climbing hills the spark is retarded slightly independent of the mechanical governor advance.

(2) The IGE-type distributors are dual type for use on twin ignition engines. This type has two sets of contacts, two condensers,

two sets of rotor and cap contacts and is used with two coils. The two primary circuits and the two secondary circuits are insulated from each other (fig. 105) and operate as two separate ignition systems. These two systems operate simultaneously to give the twin spark at the spark plugs.

(3) For model numbers of group 1 distributors, see paragraph 1.

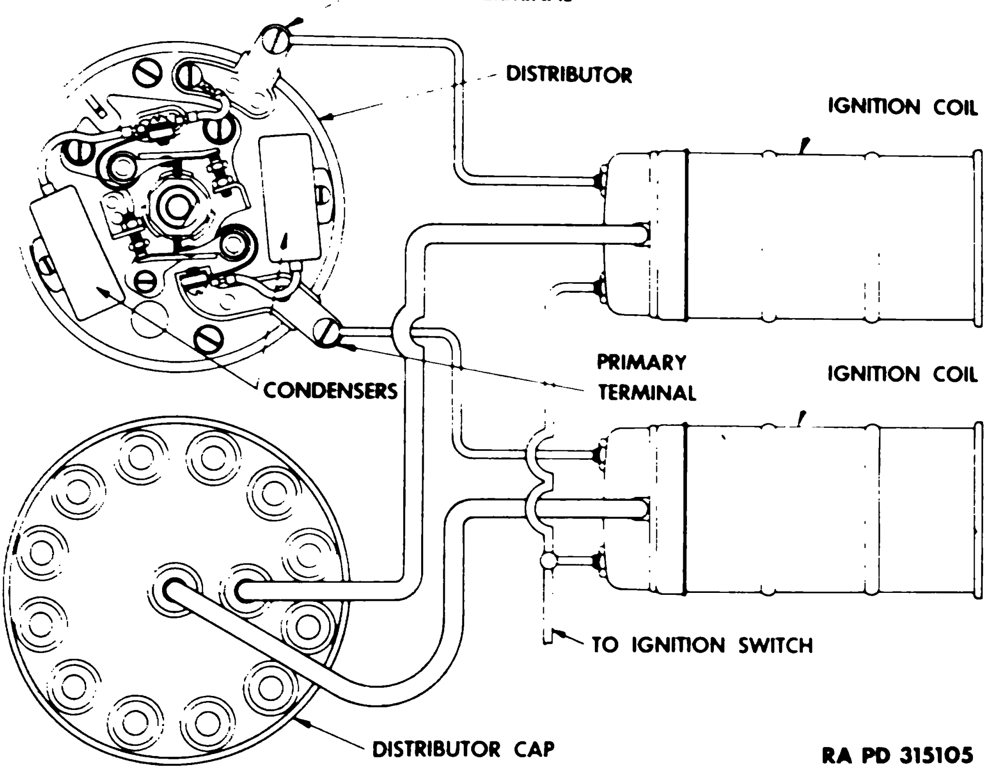


Figure 105—Typical Hookup of Twin Ignition Distributor

b. Data.

Distributor	Rotation	Cylinders	Condenser* Capacity Mfd	Contact Gap Inches	Cam Dwell	Manual Advance	Governor Max	Advance Curve	Vacuum Max	Advance Curve
IGC 4054D	L.H.	6	0.20–0.25	0.020	40°	10°	12°	CU 730	....	....
IGC 4281	R.H.	6	0.20–0.25	0.020	40°	...	6°	CU 605	....	....
IGC 4286	R.H.	6	0.20–0.25	0.020	40°	6°	6°	CU 368	....	....
IGC 4701	R.H.	6	0.18–0.26	0.020	38°	6°	6°	CU 368	....	....
IGC 4701-1	R.H.	6	0.18–0.26	0.020	38°	...	6°	CU 368	....	....
IGC 4701-2	R.H.	6	0.18–0.26	0.020	38°	...	6°	CU 368	....	....
IGC 4702A	R.H.	6	0.18–0.26	0.020	38°	...	9°	CU 756	....	....
IGC 4703,-1	R.H.	6	0.18–0.26	0.020	38°	...	10°	CU 770	....	....
IGC 4704,-1	R.H.	6	0.18–0.26	0.020	38°	...	10°	CU 770	....	....
IGC 4705	L.H.	4	0.18–0.26	0.020	42°	...	11°	CU 789	....	....
IGC 4706A	R.H.	6	0.18–0.26	0.020	38°	...	11°	CU 803	....	....
IGC 4707,-1	R.H.	6	0.18–0.26	0.020	38°	...	10°	CU 770	....	....
IGC 4708	R.H.	6	0.18–0.26	0.020	38°	6°	10°	CU 191	....	....
IGC 4709A	R.H.	6	0.18–0.26	0.020	38°	...	9°	CU 756	....	....
IGC 4710-2	L.H.	6	0.18–0.26	0.020	38°	...	16°	CU 414	....	....
IGC 4716	L.H.	6	0.18–0.26	0.020	38°	10°	12°	CU 730	....	....
IGC 4717,-1	R.H.	6	0.18–0.26	0.020	38°	...	11°	CU 774	....	....
IGC 4902A	R.H.	6	0.18–0.26	0.020	38°	...	7°	CU 378	....	....
IGE 4003H	L.H.	6	0.20–0.25†	0.020	35°	10°	12.5°	CU 676	....	....
IGE 4003H-1	L.H.	6	0.20–0.25†	0.020	35°	10°	12.5°	CU 676	....	....
IGE 4029	R.H.	6	0.20–0.25†	0.020	35°	...	9°	CU 829	....	....
IGS 4111,-1	R.H.	6	0.25–0.28	0.020	38°	...	11°	CU 480	10°	CU 620**
IGS 4112,-1	R.H.	6	0.25–0.28	0.020	38°	...	12°	CU 478	8°	CU 584**
IGS 4114,-1	R.H.	6	0.25–0.28	0.020	38°	...	12°	CU 478	8°	CU 584**
IGS 4202A,-1	R.H.	6	0.25–0.28	0.020	38°	...	11°	CU 774	6°	CU 527**
IGS 4203B,-1	R.H.	6	0.25–0.28	0.020	38°	...	10°	CU 770	8.5°	CU 767**
IGS 4204,-1	R.H.	6	0.25–0.28	0.020	38°	...	11°	CU 480	10°	CU 620**
IGT 4102	L.H.	8	0.20–0.25	0.017	27°	...	11.5°	CU 654	5.5°	CU 550**

* Located on breaker plate.
** See table below.
† Two condensers of this capacity are used.
L.H.—Left-hand rotation when viewed from top.
R.H.—Right-hand rotation when viewed from top.

DISTRIBUTORS—GROUP 1

Governor Advance Curves

Advance Curve	0° Advance RPM	1° Advance RPM	Intermediate Advance	Intermediate RPM	Maximum Advance	Less 1° RPM	Maximum Advance	Maximum RPM
CU 191	300	410	5°	850	9°	1,290	10°	1,400
CU 368	275	375	3°	580	5°	790	6°	900
CU 378	400	540	3°	830	6°	1,260	7°	1,400
CU 414	250	280	7°	450	15°	1,340	16°	1,450
CU 478	350	367	3°	400	11°	1,600	12°	1,750
CU 480	350	367	3°	400	10°	1,670	11°	1,850
CU 605	300	440	3°	725	5°	1,010	6°	1,150
CU 654	250	325	6°	700	10°	1,500	11.5°	1,800
CU 676	250	290	6°	490	11°	690	12.5°	750
CU 730	250	280	9°	500	11°	970	12°	1,200
CU 756	275	380	4°	680	8°	1,100	9°	1,200
CU 770	350	367	3°	400	9°	1,050	10°	1,150
CU 774	350	367	3°	400	10°	1,275	11°	1,400
CU 789	250	360	5°	820	10°	1,380	11°	1,500
CU 803	300	370	5°	650	10°	1,770	11°	2,000
CU 829	300	350	4°	480	8°	660	9°	700
Tolerance	±50	±50	±1°		±1°		±1°	

All figures are in distributor degrees and rpm revolutions per minute.

Vacuum Advance Curves

Advance Curve	0° Advance Inches of Hg	1° Advance Inches of Hg	Intermediate Advance	Intermediate Inches of Hg	Maximum Advance	Less 1° Inches of Hg	Maximum Advance	Maximum Inches of Hg
CU 527	$5\frac{1}{8}$	$6\frac{5}{8}$	3°	$9\frac{5}{8}$	5°	$12\frac{1}{2}$	6°	14
CU 550	7	$8\frac{5}{8}$	3°	12	4°	$13\frac{1}{2}$	5.5°	16
CU 584	5	$6\frac{3}{8}$	4°	$10\frac{1}{2}$	7°	$14\frac{5}{8}$	8°	16
CU 620	4	$6\frac{1}{4}$	5°	11	9°	$15\frac{3}{4}$	10°	17
CU 767	5	$6\frac{1}{4}$	4°	$10\frac{1}{8}$	7°	14	8.5°	16
Tolerance	±1	±1		±1	±1°		±1°	

All figures are in distributor degrees and in inches of mercury (Hg).

65. CLEANING AND INSPECTING.

a. Cleaning.

(1) Wipe outside of distributor with cloth dampened in dry-cleaning solvent. Do not soak.

(2) Snap off two cap clamp springs and lift off cap. Pull rotor from shaft being careful not to crack rotor.

(3) Wipe cap and rotor with cloth dampened in dry-cleaning solvent.

b. Inspecting.

(1) Discard cap if it is cracked, has corroded terminals or if carbon runners have formed either on inside or outside surfaces. Inspect contacts on inside of cap (fig. 106). After normal use these contacts become slightly burned on inside tip. If burning is excessive or uneven replace cap. If burning is found on horizontal face of contacts it indicates rotor is too short and must be replaced. Clean contacts with carbon tetrachloride but do not file. Replace the carbon contact in center of cap if cracked, stuck or too short to contact rotor. Contact is snap fit and can be removed by pulling.

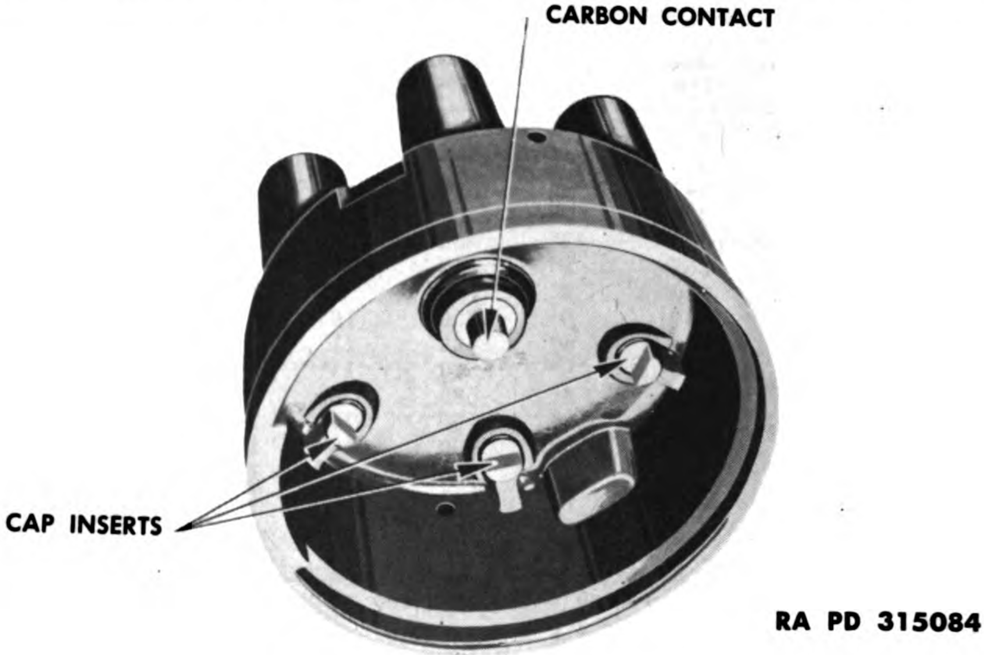


Figure 106—Distributor Cap

(2) Discard rotor if it is cracked, has loose contact strip or if burning is found on top of strip. Inspect end of contact. If burning is excessive replace rotor. If burning is only slight clean with carbon tetrachloride. Do not file.

66. DISASSEMBLY.

a. **Remove Advance Arm** (if pertinent).

(1) With straightedge and sharp point mark relationship between advance arm and base.

(2) Loosen clamp screw and remove arm from base. On some types it is necessary to remove screw, lock washer, and plain washer, holding arm to base. Remove large thrust washer.

b. **Remove Vacuum Chamber** (if pertinent). Take out two screws and lock washers holding vacuum chamber bracket to base. Unhook arm from subbase plate and lift off vacuum chamber.

c. **Remove Radio Shield** (if pertinent). Remove oiler from base. Take out four screws holding shield to base and lift off.

d. **Remove Radio Filter** (if pertinent). Remove connector from primary terminal. Take out filter mounting screws and lift off.

e. **Note Rotor Alinement** (Distributors with tongue drive only). Install rotor on shaft and note position of rotor in relation to drive tongue. Most drive tongues are not centered. This offset must be noted when checking alinement. Sketch relationship for use during assembly. Remove rotor.

f. **Remove Breaker Plate.** Take out two screws and lift plate from base. On IGS and IGT types remove two bearing clamps. Remove terminal slot cover from terminal.

DISTRIBUTORS—GROUP 1

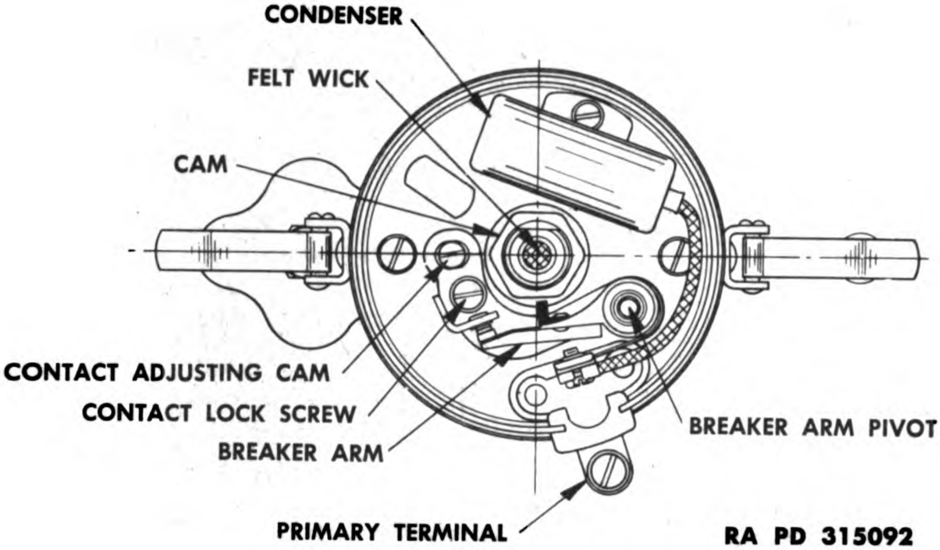


Figure 107—Breaker Plate for IGC 4700 Series Distributors

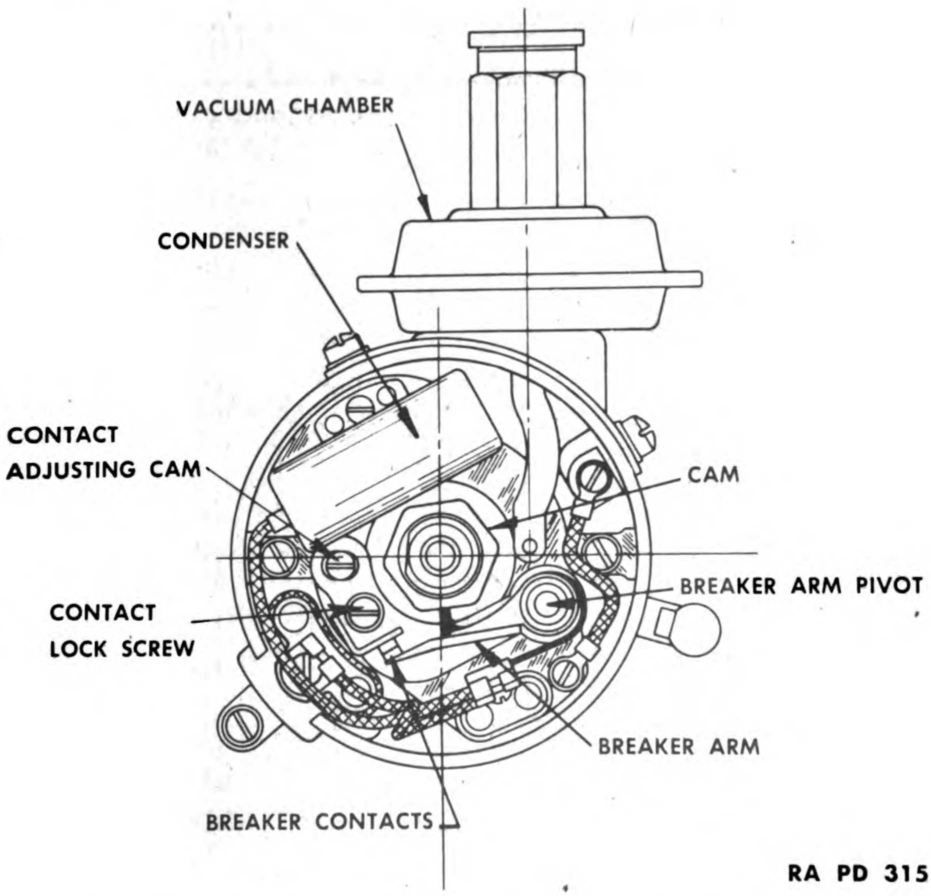


Figure 108—Breaker Plate for IGS-type Distributors

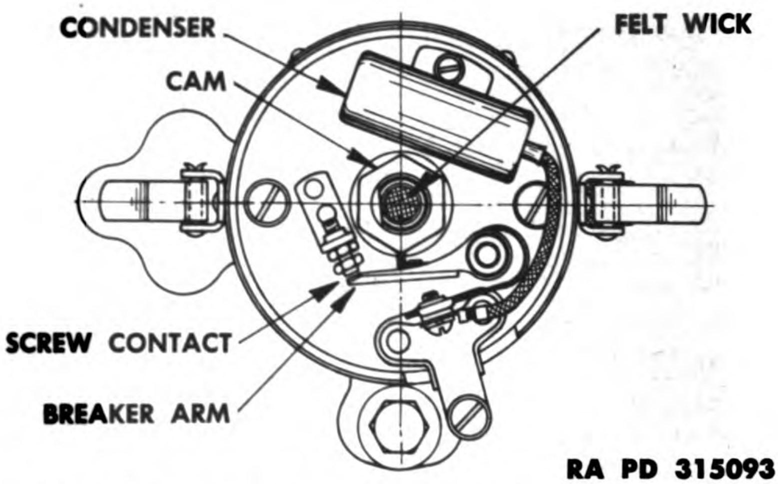


Figure 109—Breaker Plate for IGC 4200 Series Distributors

g. **Remove Cam.** Remove felt wick from cam sleeve. Take out snap ring in sleeve. Lift off cam and spacer.

67. CLEANING OF COMPONENTS.

a. **Breaker Plate** (figs. 107, 108, 109, and 110).

(1) On IGS and IGT types remove screw and clamp holding breaker arm spring. Remove condenser and breaker arm from sub-

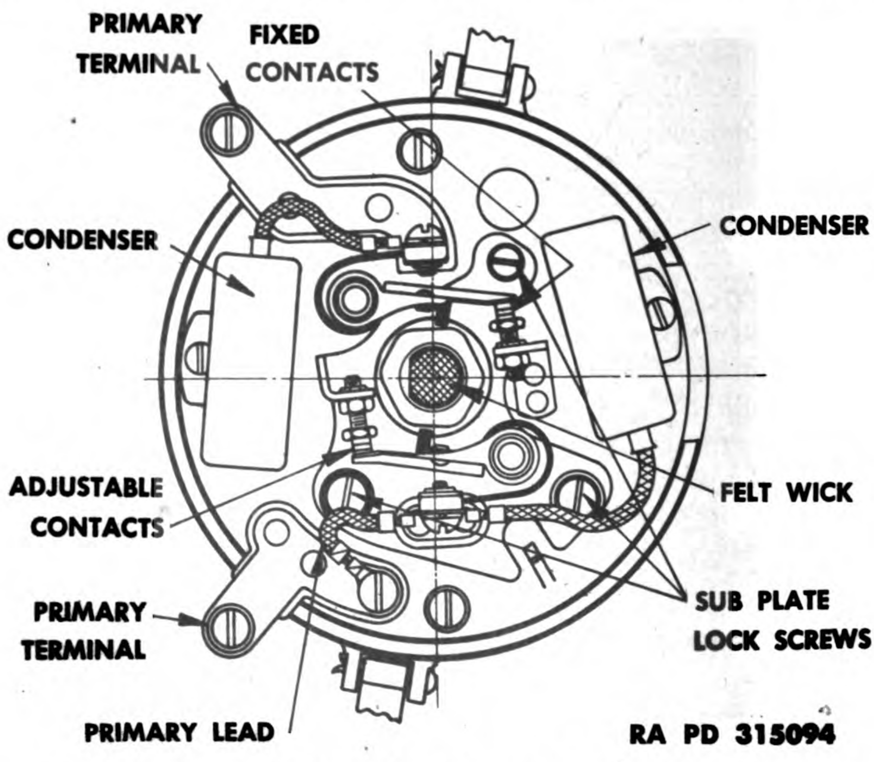


Figure 110—Breaker Plate for IGE-type Distributors

plate. Remove ground lead from subplate. Press subplate out of base plate. Soak subplate and bearing in dry-cleaning solvent and clean and dry thoroughly.

(2) Dip, do not soak, breaker plate, condenser, contact arm and leads in dry-cleaning solvent and clean with soft rag. Dry thoroughly with compressed air.

(3) Clean contacts with carbon tetrachloride and linen tape. Dampen tape with carbon tetrachloride and rub contacts. Rub contacts dry with clean dry tape.

b. Cam. Clean cam in dry-cleaning solvent and dry thoroughly.

c. Vacuum Chamber. Wipe outside of chamber, bracket and arm with cloth dampened in dry-cleaning solvent.

d. Advance Arm and Radio Shield. Soak in dry-cleaning solvent and thoroughly clean and dry.

e. Radio Filter. Wipe clean with cloth dampened in dry-cleaning solvent.

f. Base and Governor. Wipe governor and base as clean as possible with cloth dampened in dry-cleaning solvent. Do not soak. Dry immediately with clean, dry, compressed air.

68. INSPECTION AND TEST OF COMPONENTS.

a. Breaker Plate (figs. 107, 108, 109, and 110).

(1) Remove condenser lead screw, lock washer and spring clamp.

(2) Inspect breaker plate for stripped threads and discard plate if defective. Check insulated primary terminal for grounds with test probes and discard plate if terminal is grounded.

(3) Test condenser for capacity and grounds on condenser tester. Install new condenser if it is grounded, leaky or if the capacity is not within limits (par. 64 **b**). Make sure lead is not broken and that lead insulation is in good condition.

(4) Inspect ball bearing for wear and make sure it turns freely. Discard subplate if the bearing is worn or corroded.

(5) Inspect contacts. If they are a grayish color and are not pitted or burned they need not be replaced. If contacts are rough, burned, or pitted, install new contacts (par. 69 **a** (5)).

(6) Turn breaker arm on pivot. It must turn freely without binding or looseness. Remove breaker arm and inspect pivot. Discard breaker plate if wear is evident on pivot or if pivot is not perpendicular to plate. If pivot is in good condition install new contacts to obtain the correct pivot fit.

(7) Inspect leads for breaks and frayed insulation and replace (par. 69 **a**) if not in good condition.

(8) Assemble breaker plate (par. 69 **a**) using new parts where necessary.

b. Cam.

(1) Replace cam if lobes are grooved or if sides of weight slots are rough.

(2) If an antirattle spring is used, inspect for distortion, and replace if bent out of shape. When installing new spring bend end over after assembly.

c. **Radio Filter** (if pertinent). Touch one direct current test probe to base and touch other probe to either terminal. If lamp lights replace filter. Touch test probes to two filter terminals. If lamp fails to light replace filter.

d. **Vacuum Chamber.**

(1) Inspect for dents, cracks, and bent arm. Straighten if possible and replace if bracket and arm do not line up correctly when assembled on distributor.

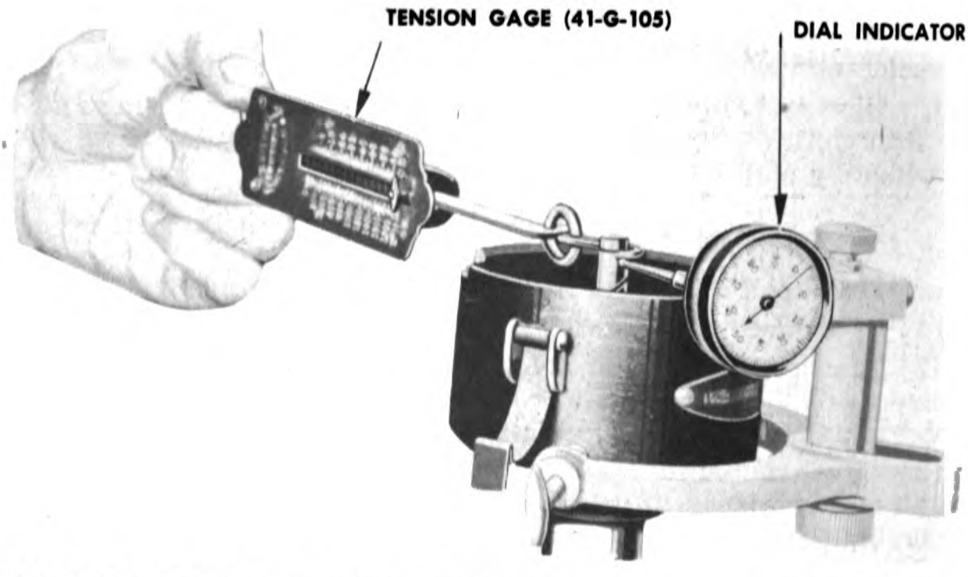


Figure 111—Measuring Side Play of Shaft with Indicator (41-I-100)

(2) Remove spring seat plug, gasket, washers and spring. Clean these parts in dry-cleaning solvent and inspect for distortion. Install spring, washers, gasket and plug and tighten.

(3) Connect vacuum chamber to vacuum line with gage. Apply five to seven inches of vacuum and hold vacuum pump at that point. If vacuum reading falls it indicates a leak in either pump or chamber. To check pump, plug vacuum line and try same test. A slight leak in vacuum chamber will not impair operation but chamber must be replaced if vacuum falls quickly.

e. **Base and Governor.**

(1) Slip governor springs off lugs on weight carrying plate. Slide governor weights off pivots.

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(2) Inspect weight pivots and pivot holes for wear. Weights must pivot easily without looseness or binding. Install new shaft or weights if pivots are too loose or too tight (par. 69 **b**).

(3) Discard governor springs if they are bent or distorted.

(4) Clamp indicator (40-I-100) on base with plunger resting against side of shaft. Hook spring scale on shaft and apply a five-pound pull in line with indicator plunger (fig. 111). Install new drive shaft bearings (par. 69 **b**) if side play is more than 0.005 inch.

Figure 112—Measuring End Play of Shaft with Thickness Gage (41-G-400)

(5) Clamp dial indicator on base with plunger against end of shaft. Move shaft to its two extreme positions and read total end play. End play can also be measured with a thickness gage inserted between bottom of base and lower thrust washer (fig. 112). If end play is less than 0.003 inch tap lower end of shaft to loosen. If end play is more than 0.010 inch remove drive gear, coupling or collar (par. 69 **b**) and install additional thrust washers between base and collar.

(6) Inspect gear, coupling, or drive tongue for wear. Install new gears (par. 69 **b**) if wear is not evenly distributed or if teeth are damaged. Install new coupling or shaft if tongue is damaged or severely worn.

69. REPAIR AND REBUILDING OF COMPONENTS.

a. Breaker Plate (figs. 107, 108, 109, and 110).

(1) On IGS and IGT types, pack ball bearing ½ full with high temperature grease. Remove excess grease from plate and bearing and wipe plate with cloth dampened in dry-cleaning solvent. Keep dirt out of bearing and keep grease away from insulation, contacts and

leads. Place subplate on base plate and aline stop with hole in base plate. Press bearing into recess and inspect to make sure it is completely seated.

(2) On IGE-type distributors install subplate on base plate and install and tighten three screws, lock washers and plain washers.

(3) Install stationary contact. On screw type install lock nut on contact then screw contact into bracket. On cam type contacts, place contact over pivot pin and adjusting cam and fasten with screw and plain washer. Install two contacts on IGE type.

(4) Place condenser in position on plate. Install screw and lock washer and tighten. Install two condensers on IGE type.

(5) Install spring in breaker arm and place arm on pivot. On IGC type install spring and connector on inside of spring holder and on IGE, IGS, and IGT types install spring and connector on outside of holder. Install washer and condenser lead terminal on screw. On IGE, IGS, and IGT, also install primary lead terminal on screw. Place spring clamp over breaker arm spring and install screw. Arrange leads so they will not interfere with arm and rotor movement and tighten screw. On IGE type install second breaker arm in same manner except no primary lead is used.

(6) On IGS and IGT types install ground lead and primary lead on plate. Arrange leads so they will not interfere with rotation of subplate. Connect primary lead to contact spring clamp screw and primary terminal and connect ground lead to the two plates.

b. Base and Governor.

(1) On distributors with drive tongue on collar sketch relationship between tongue and weight carrying plate on shaft. Be sure to note direction of offset on tongue.

(2) Remove rivet and take gear, collar or coupling off shaft. Take off lower thrust washer and remove bur from rivet hole in shaft. Pull shaft out of base and remove upper thrust washer. Drive out old bearings with arbor or bolt that rests on bearing without gouging bearing bore.

(3) Install new bearings on arbor of correct size to give proper bearing diameter (par. 72 **b**) and press bearings into place. Install lower bearing flush with bottom of base and install upper bearing 0.094 inch below face of bearing bore. On distributors using an upper bearing with a ⅛-inch hole, be sure this hole is lined up with oil hole in base. On distributors using a bearing without a hole, continue oil hole in base through bearing using drill of same diameter. Remove all burs from inside of bearing, being careful not to mar bearing.

(4) Install felt wick, if used, in oil hole and install oiler or grease cup.

(5) Soak bearings in engine oil (SAE 30) and drain off excess oil. Do not get oil in upper part of base.

(6) Install upper thrust washer on shaft and place shaft in bearings. Install lower thrust washer and gear, collar or coupling on shaft. Turn coupling to alinement noted (par. 69 **b** (1) above). Drill

rivet hole in shaft to correspond to hole in collar, coupling or gear. Install rivet and swedge so both ends are riveted over and spread to fill hole.

(7) Check side and end play of shaft (par. 68 e (4) and (5)).

70. ASSEMBLY.

a. **Lubrication.** Soak felt wick in engine oil (SAE 30). Apply thin coat of engine oil (SAE 30) to weight pivot pins, to slots in yoke and to upper end of shaft. Apply one drop only of engine oil (SAE 10) to breaker arm hinge pin. Operate arm once or twice then wipe off excess oil. Add three to five drops engine oil (SAE 30) to oiler on side of base. Fill grease cup with high temperature grease and turn cup down one complete turn after air is expelled. Apply thin coat of high temperature grease to cam. On governor weights with grease recess in pivot hole pack this hole with high temperature grease (fig. 113). Do not over-lubricate. Wipe off excess oil or grease.

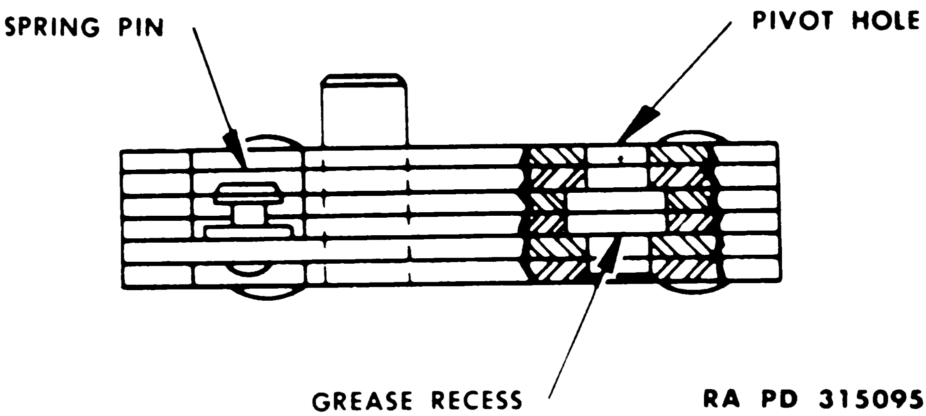

Figure 113—Governor Weight Grease Recess

b. **Assemble Governor.** Place weights on pivots. Hook springs over weight pins then over outer pins. Be sure springs are settled into grooves.

c. **Install Cam.**

(1) Place spacer on shaft with chamfered side down. Install cam on shaft and install weight pins into slots. If antirattle spring is used hold spring and turn cam so spring will bear against weight controlled by weak weight spring. If both springs are alike either weight will do until checked as in following step.

(2) Place rotor on cam and check relationship between rotor and drive tongue. This must be same as noted during disassembly (par. 66 e). If it is not, lift cam and turn 180 degrees then install. It may be necessary to interchange weight springs to have antirattle spring work on weak spring side. Remove rotor.

(3) Install cam retaining lock ring and press into place.

(4) Install felt wick in top of cam.

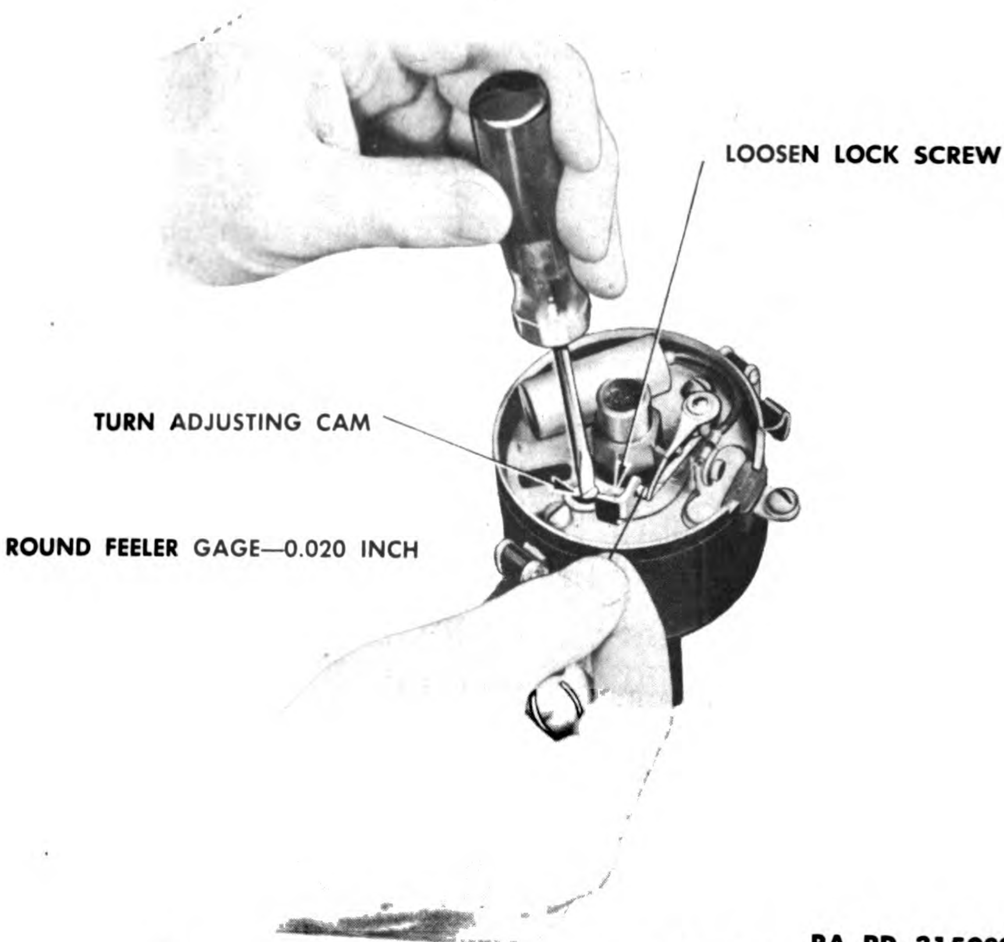

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Figure 114—Adjusting Cam-type Contacts

d. **Install Breaker Plate.** Install slot cover on primary terminal and install plate in base. Install bearing clamps on IGS and IGT types. Install plate screws and lock washers and tighten.

e. **Install Radio Shield** (if pertinent). Remove oiler from base. Install shield on base and install screws and lock washers. Install oiler.

f. **Install Vacuum Chamber** (if pertinent). Place vacuum chamber on base and hook arm on pin in subbase plate. Install bracket attaching screws and lock washers. Be sure chamber and bracket are settled in place and tighten screws.

g. **Install Radio Filter** (if pertinent). Install filter on base and install holding screws and washers. Tighten screws. Place connector in place on terminals and install and tighten terminal screws and lock washers.

h. **Install Advance Arm.** Place large washer on base and install arm on base. Turn arm so marks made during disassembly (par. 66 a) are alined. Tighten clamp screw.

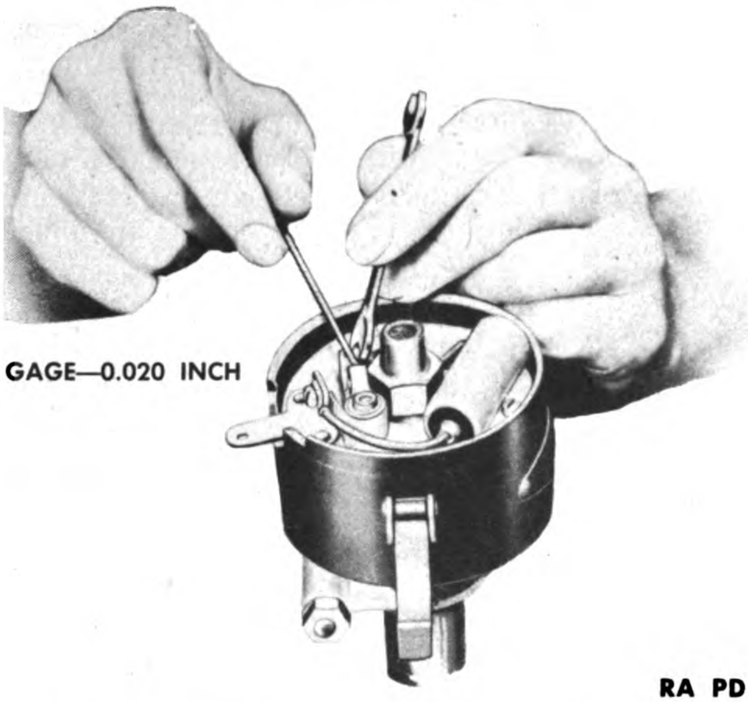

Figure 115—Adjusting Screw-type Contacts

71. TESTS AND ADJUSTMENTS.

a. Adjust Contact Gap.

(1) Turn shaft so that breaker arm rubbing block is on high point of cam.

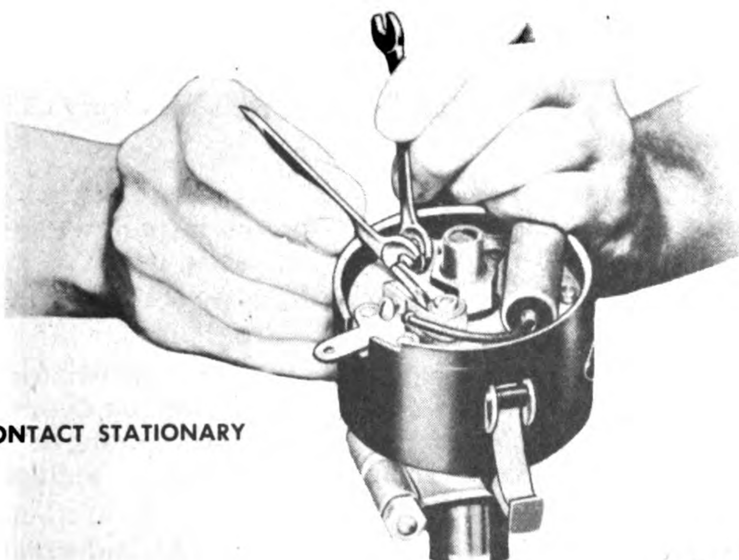

Figure 116—Tightening Contact Lock Nut

(2) Slightly loosen stationary contact lock screw or nut. Adjust contact gap to 0.020 inch for four- and six-cylinder distributors or to 0.017 inch for eight-cylinder distributors. Adjust by turning adjusting cam (fig. 114) or by screwing the stationary contact in or out (fig. 115). Use wire feeler gage to check contact gap as there is less chance for error than with flat gage. Tighten lock screw or nut (fig. 116).

(3) Turn shaft so that contacts are closed. Inspect contact alinement. Bend stationary contact bracket so contacts are alined for full face contact.

(4) Adjust contact gap (par. 71 **a** (1) and (2) above.)

(5) On IGE-type distributors repeat above procedure on second set of contacts.

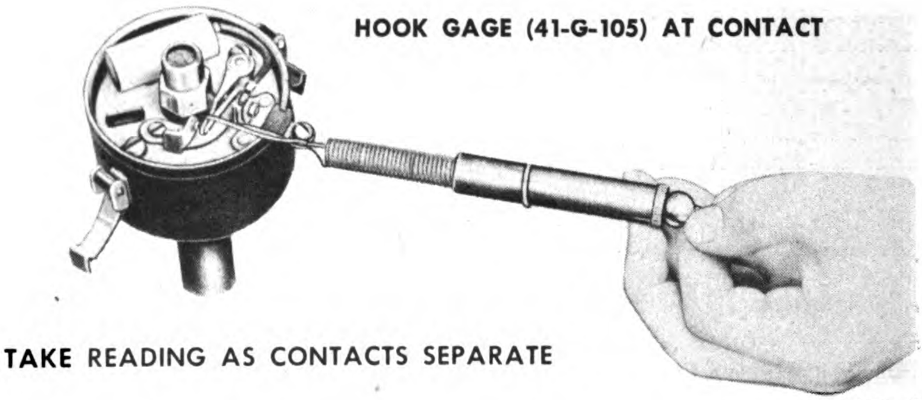

Figure 117—Measuring Contact Pressure

b. Adjust Contact Pressure.

(1) Hook tension gage (41-G-105) on contact arm at contact and pull on line with contacts (fig. 117). Take reading just as contacts separate. Adjust tension to 17 to 20 ounces by loosening screw holding breaker arm spring and sliding spring in or out as necessary. Tighten screw, then check pressure.

(2) On IGE type adjust tension of second set of contacts to same limits.

c. Adjust Cam Dwell.

(1) Mount distributor on test fixture and connect test leads. Set fixture for correct rotation (par. 64 **b**).

(2) Start test fixture and operate at about 1,000 distributor revolutions per minute. Read cam dwell. Adjust to specified figure (par. 64 **b**) by loosening stationary contact lock screw and turning adjusting cam or loosening lock nut and screwing contact in or out. Tighten lock screw or nut and check cam dwell.

(3) On IGE-type distributors set cam dwell of second set of contacts to exactly same value as first set. To adjust second set change test lead to other primary terminal and proceed as above.

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d. Synchronize IGE-type Distributors.

(1) Mount distributor on test fixture that has two leads and lights to show firing point in degrees. Connect one lead to each primary terminal on distributor. Operate in correct rotation (par. 64 b) at about 1,000 distributor revolutions per minute. The indicators for the two sets of contacts should be exactly synchronized. If they are not, loosen three screws holding subbase plate and rotate plate slightly by inserting screwdriver between subplate and lug on base plate (fig. 110). Tighten screws and check synchronization.

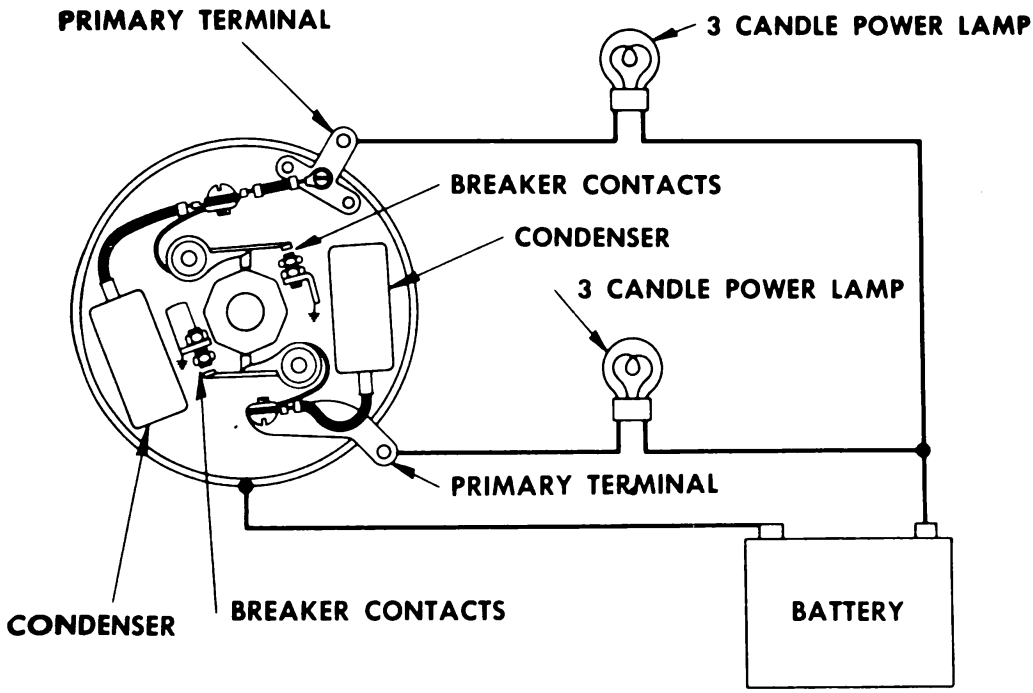

Figure 118—Hookup for Synchronizing Twin Ignition Distributor Contacts

(2) If no test fixture is available for synchronizing twin ignition distributors, synchronize with two test lamps and battery (fig. 118). Turn drive shaft in correct rotation (par. 64 b) until lamp controlled by fixed contacts goes out. Second lamp must go out at same instant. If it does not, loosen three screws holding subbase plate and turn plate. Tighten screws and check.

e. Adjust Governor.

(1) Mount distributor on test fixture and connect test leads. Set fixture for correct rotation (par. 64 b) and set controls for synchronization test.

(2) Start fixture and increase speed slowly until spark just begins to advance. Reduce speed 75 to 150 revolutions per minute and set indicator to zero.

(3) Start fixture and increase speed until one degree advance obtained, then read speed. If speed is not as specified (par. 64 b).

distributor. If speed was too high, decrease tension on weak weight spring by bending outer spring lug. If speed was too low increase tension on weak spring. On distributors with both springs alike consider one spring as weak spring and other as a heavy spring and make adjustments as described.

(4) Check zero setting then check and adjust one degree point (par. 71 e (2) and (3) above).

(5) Increase distributor speed until advance is one degree less than maximum (par. 64 b) and read speed. If speed is too high or too low stop distributor and change strong spring tension by bending outer spring lug. Increasing tension increases speed at which advance occurs.

(6) Check advance at all points in specifications and make whatever adjustments are necessary to bring all points within the tolerance in specifications (par. 64 b).

(7) Check advance both up and down speed range. If there is more than ½ degree difference in any one point it indicates friction in governor.

f. Adjust Vacuum Advance (if pertinent).

(1) Connect and operate test fixture as in governor adjustment. Connect vacuum line to vacuum chamber. Operate at about 2,000 revolutions per minute to eliminate variations due to governor. Set indicator to zero. Apply vacuum to distributor until 1 degree advance is obtained. Read vacuum gage which should be within specifications (par. 64 b). If vacuum reading is too low, remove spring seat plug and add washers to increase spring tension. Remove washers if vacuum reading was too high. Install gasket and plug and check advance.

(2) When one point on curve is adjusted check all points in specifications (par 64 b). If curve cannot be set within limits at all points remove spring seat plug, install new spring and adjust.

g. Complete the Assembly.

(1) Clean contacts with linen tape and carbon tetrachloride. Be sure no lint is left on contacts.

(2) Install rotor on shaft. Be sure rotor is pressed down on shaft.

(3) Turn shaft and arrange leads so that they do not interfere with movement.

(4) Install cap on distributor. Turn cap so projection fits into slot and snap cap clamp springs into place.

72. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Cylinders—(see tabulation) (par. 64 b).

Control—(semi or full automatic).

Bearings—Two absorbent bronze bearings in lower part of base. IGS and IGT types also have ball bearing on breaker subplate.

Lubrication—At assembly add one drop of oil (SAE 30) to governor weight pivots and slots and soak bearings and felts in oil (SAE 30). Apply one drop of oil (SAE 10) to breaker arm pivot pin and remove excess oil. Apply light wipe of high temperature grease to cam. Add

three to five drops of oil (SAE 30) to oiler. Fill grease cup with high temperature grease and turn down one turn. Do not over-lubricate distributor.

b. Mechanical.

Rotation—(see tabulation) (par. 64 **b**).

Contact gap—

IGC, IGE, and IGS type 0.018 to 0.022 in.

Set maximum gap to 0.020 in.

IGT type 0.015 to 0.019 in. Set maximum gap to 0.017 in.

Contact pressure—17 to 20 oz.

Bearing diameter—New bearings—0.4995 to 0.5000 in.

Side play—New bearings and shaft—0.001-inch maximum. Fit new bearings to 0.0005-inch maximum side play.

Side play—Worn bearings and shaft—0.005-inch maximum.

End play—0.003 inch to 0.010 inch. Measure after gear, collar, or coupling, is pinned in place.

c. Electrical.

Cam dwell—(see tabulation) (par. 64 **b**).

Condenser capacity—(see tabulation) (par. 64 **b**).

Maximum governor advance—(see tabulation) (par. 64 **b**).

Governor advance curve—(see tabulation) (par. 64 **b**).

Maximum vacuum advance—(see tabulation) (par. 64 **b**).

Vacuum advance curve—(see tabulation) (par. 64 **b**).

Manual advance—(see tabulation) (par. 64 **b**).

d. Tabulated Specifications (par. 64 **b**).

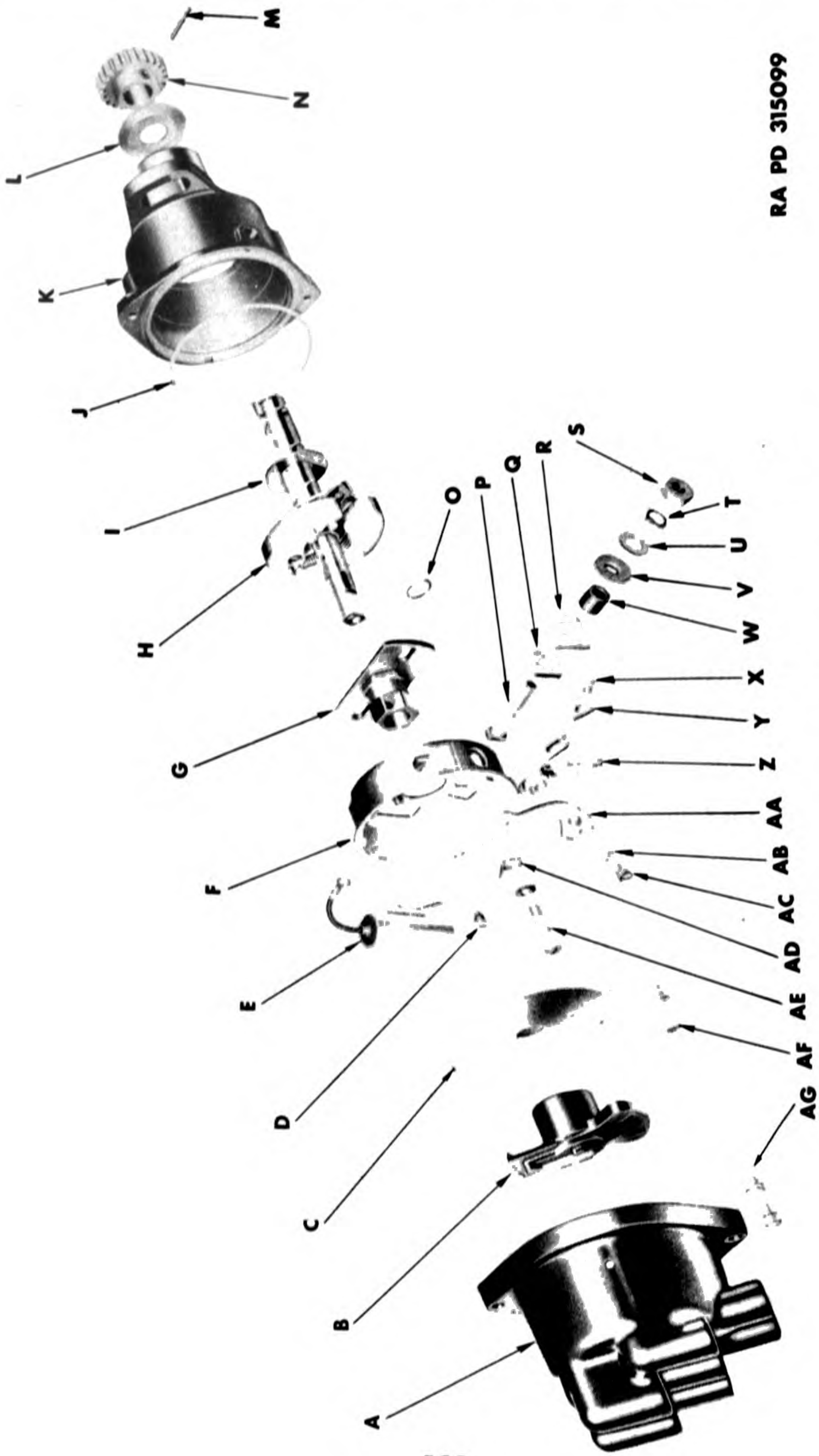

Figure 119—Components of Group 2 Distributors

CHAPTER 4

DISTRIBUTORS (Cont'd)

Section III

DISTRIBUTORS—GROUP 2

73. DESCRIPTION AND DATA.

a. **Description** (fig. 119). Group 2 distributors are heavy-duty units for use on six-cylinder engines. They are completely sealed to exclude water and dust. These distributors are fully automatic with centrifugal governor control of the timing. For model numbers of group 2 generators, see paragraph 1.

A—CAP
B—ROTOR
C—SEAL PLATE
D—CONDENSER MOUNTING SCREW
E—CONDENSER
F—BREAKER PLATE
G—CAM
H—DRIVE SHAFT AND GOVERNOR
I—UPPER THRUST WASHER
J—CAP GASKET
K—BASE ASSEMBLY
L—LOWER THRUST WASHER
M—DRIVE GEAR RIVET
N—DRIVE GEAR
O—CAM LOCK RING
P—TERMINAL STUD
Q—TERMINAL STUD CLAMP
R—TERMINAL STUD INNER INSULATION
S—TERMINAL STUD NUT
T—TERMINAL STUD LOCK WASHER
U—TERMINAL STUD PLAIN WASHER
V—TERMINAL STUD INSULATING WASHER
W—TERMINAL STUD INSULATING BUSHING
X—BREAKER ARM SPRING CLAMP SCREW
Y—BREAKER ARM SPRING CLAMP
Z—BREAKER ARM
AA—BREAKER CONTACT
AB—PLAIN WASHER
AC—CONTACT LOCK SCREW
AD—LOCK WIRE CLAMP
AE—BREAKER PLATE MOUNTING SCREW
AF—SEAL PLATE MOUNTING SCREW
AG—CAP MOUNTING SCREW

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Legend for Figure 119—Components of Group 2 Distributors

b. **Data.**

Distributor	Rotation	Condenser* Mfd	Contact Gap Inches	Cam Dwell	Governor Advance	Advance Curve
IAC 4001	L.H.	0.20–0.24	0.018–0.022	38°	12° (dist)	CU 419
IAC 4002	L.H.	0.20–0.24	0.018–0.022	38°	12° (dist)	CU 419
IAC 4002A	L.H.	0.20–0.24	0.018–0.022	38°	12° (dist)	CU 845
IAC 4003	R.H.	0.20–0.24	0.018–0.022	38°	10° (dist)	CU 191

L.H.—Left hand rotation when viewed from top.
R.H.—Right hand rotation when viewed from top.
* Located on breaker plate.

Advance Curves	CU 191	CU 419	CU 845
Start advance	0° at 300 RPM	0° at 350 RPM	0° at 425 RPM
Intermediate advance	1° at 410 RPM	1° at 370 RPM	1° at 450 RPM
Intermediate advance	5° at 850 RPM	3° at 400 RPM	4° at 525 RPM
Intermediate advance	9° at 1,290 RPM	11° at 1,400 RPM	11° at 1,400 RPM
Full advance	10° at 1,400 RPM	12° at 1,530 RPM	12° at 1,525 RPM

Figures given are distributor RPM and degrees—engine RPM and degrees are double these figures.

74. CLEANING AND INSPECTING.

a. **Cleaning.**

(1) Wipe outside of distributor with cloth dampened in dry-cleaning solvent. Do not soak.

(2) Take out two screws and lift off cap and cap gasket. Pull rotor from shaft, being careful not to crack rotor. Take out three screws and lift off seal plate.

(3) Wipe cap, rotor and seal plate with cloth dampened in dry-cleaning solvent.

b. **Inspecting.**

(1) Discard cap if it is cracked, has corroded terminals or if carbon runners have formed either on inside or outside surfaces. Inspect contacts on inside of cap. After normal use these contacts become slightly burned on inside tip (fig. 106). If burning is excessive or uneven replace cap. If burning is found on horizontal face of contacts it indicates rotor is too short and must be replaced. Clean contacts with carbon tetrachloride but do not file. Install new carbon contact in center of cap if carbon is cracked, stuck or if too short to contact rotor. The carbon contact is a snap fit and can be removed by pulling.

(2) Discard rotor if it is cracked, has loose contact strip, or if burning is found on top of strip. Inspect end of contact. If burning is excessive replace rotor. If burning is only slight clean with carbon tetrachloride. Do not file.

(3) Place seal plate on base and inspect seal around cam. Discard seal plate if seal does not fit against cam on all sides. Remove seal plate.

75. DISASSEMBLY.

a. **Remove Terminal Stud.** Remove nut, lock washer, plain washer and insulating washer from terminal stud. Move terminal stud

slightly to work insulating bushing out of base. Remove insulating bushing. Lift terminal stud, clamp and insulation out of distributor.

b. Remove Breaker Plate. Take out two screws, lock washers, and clamps, and lift plate out of base. Remove gasket.

c. Remove Cam. Remove snap ring and lift cam from shaft. Remove cam spacer from shaft.

d. Remove Felt Wick. Pull wick from top of shaft with small hook.

76. CLEANING OF COMPONENTS.

a. Breaker Plate.

(1) Dip plate in dry-cleaning solvent. Blow off with clean dry compressed air.

(2) Clean contacts with carbon tetrachloride and linen tape. Dampen tape with carbon tetrachloride and rub contacts. Repeat with dry tape to remove any residue.

b. Cam. Clean cam in dry-cleaning solvent and dry thoroughly.

c. Terminal Stud and Washers. Clean terminal stud, washers, clamp and bushing in cleaning solvent. Do not soak insulating parts in solvent.

d. Base and Governor. Wipe governor and inside of base as clean as possible with cloth dampened with dry-cleaning solvent. Do not soak. Dry immediately with clean dry compressed air.

77. INSPECTION AND TEST OF COMPONENTS.

a. Breaker Plate.

(1) Remove condenser lead screw, lock washer, and spring clamp.

(2) Test condenser for capacity and grounds on condenser tester. It is not necessary to remove condenser from plate to test. Install new condenser if it is grounded, leaky, or if capacity is not within limits (par. 81 c). Make sure condenser is firmly mounted and that lead is not chafed or broken. Lock-wire mounting screws.

(3) Inspect contacts. If they are a grayish color and are not pitted or burned they need not be replaced. If contacts are rough, burned or pitted install new contacts (par. 78 a).

(4) Turn breaker arm on pivot. It must turn freely without binding or looseness. Remove breaker arm and inspect pivot. Replace plate if wear is evident on pivot or if pivot is not perpendicular to plate. If pivot is in good condition install new contacts to obtain correct pivot fit.

(5) Inspect plate for stripped threads and replace plate if any are found. Check insulated primary terminal for grounds with test probes and replace plate if ground is present.

b. Cam. Replace cam if lobes are grooved or if sides of weight slots are rough.

c. Terminal Stud and Washers. Discard stud if corroded or stripped and replace insulation if cracked or oil soaked.

d. **Base and Governor.**

(1) Slip governor springs off lugs on weight carrying plate. Pull governor weights from pivots.

(2) Inspect weight pivots and pivot holes for wear. Weights must pivot easily without looseness or binding. Install new shaft (par. 78 **b**) or weights if pivots are too loose or too tight.

(3) Replace governor springs if they are bent or distorted.

(4) Clamp dial indicator on base with plunger resting against side of shaft. With spring scale apply a five-pound pull in line with plunger (fig. 111). Install new drive shaft bearings (par. 78 **b**) if side play is more than 0.003 inch.

(5) Clamp dial indicator on base with its plunger against end of shaft. Move shaft to its two extreme positions and read total end play. End play can also be measured with flat feeler gage inserted between bottom of base and lower thrust washer (fig. 112). If end play is less than 0.003 inch tap lower end of shaft to loosen. If end play is more than 0.010 inch remove drive gear (par. 78 **b**) and install additional thrust washers between base and gear.

(6) Inspect gear for wear. Install new gear (par. 78 **b**) if wear is not evenly distributed or if teeth are damaged.

(7) Install new base (par. 78 **b**) if it is cracked or if threads are stripped.

78. REPAIR AND REBUILDING OF COMPONENTS.

a. Breaker Plate. Remove lock screw and washer from faulty stationary contact. Take out condenser lead screw, lock washer, and spring clamp. Pull arm from plate and remove stationary contact. Install new stationary contact on pivot pin and adjusting cam and install screw and washer. Install breaker arm spring in arm and place arm on pivot. Install connector and spring on inside of spring holder. Install lock washer and condenser terminal on hex head screw and install in spring lug. Install spring clamp on screw and tighten.

b. Base and Governor (if necessary).

(1) SHAFT, GEAR, BASE, OR BEARING REMOVAL. Remove gear rivet, gear and Woodruff key, if used, from shaft. Gear is shrunk fit on shaft and must be pressed off with arbor press. Take off lower thrust washer and pull shaft out of base. Remove upper thrust washer and oil seal. Drive old bearings out of base with arbor or bolt that rests on bearing without damaging bearing bore.

(2) SHAFT, GEAR, BASE OR BEARING INSTALLATION.

(a) Assemble new bearings on arbor of correct size to give proper bearing diameter (par. 81 **b**). Line up oil hole and press bearings into place. Install lower bearing flush with bottom of base and install upper bearing flush with bottom of recess. On IAC 4003 drill oil hole through bearing and remove all bur.

(b) Soak bearings in engine oil (SAE 30) and drain off excess oil. Do not get oil in upper part of base.

(c) Install oil seal in base. Install upper thrust washer on shaft and place shaft in bearings. Install lower thrust washer, key, and gear, on shaft. Heat gear to 350°F before pressing on shaft. Drill rivet hole through shaft to correspond to rivet hole in gear. Install rivet and swage so that both ends are riveted over and pin swells to fill hole.

(3) Check end play and side play (par. 77 d (4) and (5)).

79. ASSEMBLY.

a. Lubrication. Soak felt wick in engine oil (SAE 30). Apply thin coat of engine oil (SAE 30) to weight pivot pins, to slots in yoke and to upper end of shaft. Apply one drop only of engine oil (SAE 10) to breaker arm hinge pin. Operate arm once or twice then wipe off excess oil. On IAC 4003 fill grease cup with high temperature grease and turn cup down one complete turn after air is expelled.

b. Install Felt Wick. Make sure oil hole in shaft is not plugged then install wick in upper end of shaft. Push wick down to bottom of hole. Remove any oil from inside of base.

c. Assemble Governor. Place weights on pivots. Hook springs over weight pins then over outer pins. Be sure springs are settled into grooves.

d. Install Cam. Place spacer and cam on shaft and install lock ring.

e. Assemble Breaker Plate.

(1) Assemble breaker arm spring and connector on inside of spring holder. Install hex-head screw, lock washer and condenser terminal. Install spring clamp on screw and tighten.

(2) Place plate in base and aline terminal post holes. Install two holding screws, lock washers, and clamps. Tighten and lock-wire screws.

f. Install Terminal Post. Install clamp on post and install post and inner insulation in distributor. Install insulating bushing, insulating washer, plain washer, lock washer and nut on post and tighten.

80. TESTS AND ADJUSTMENTS.

a. Adjust Contact Gap.

(1) Turn shaft so breaker arm rubbing block is on high point of cam.

(2) Loosen stationary contact lock screw slightly. Adjust contact gap to 0.020 inch by turning adjusting cam (fig. 114). Use wire feeler gage to check contact gap as there is less chance for error than with flat gage. Tighten lock screw.

(3) Turn shaft until contacts close. Inspect contact alinement. Bend stationary contact bracket to aline contacts for full face contact.

(4) Adjust contact gap (par. 80 a (1) and (2) above).

b. Adjust Contact Pressure. Hook spring scale on contact arm at contact and pull on line with contacts (fig. 117). Take reading just as contacts separate. Adjust tension to 17 to 20 ounces by loosening

screw holding breaker arm spring and sliding spring in or out as necessary. Tighten screw then check pressure. Lock-wire screw after adjustment is completed.

c. Adjust Cam Dwell.

(1) Mount distributor on test fixture and connect test leads. Set fixture for correct rotation (par. 81 **b**).

(2) Start test fixture and operate at about 1,000 distributor revolutions per minute. Read cam dwell. Adjust to 38 degrees by loosening stationary contact lock screw and turning contact adjusting cam (fig. 114). Tighten and lock wire screw then check cam dwell.

d. Adjust Governor.

(1) Mount distributor on test fixture and connect test leads. Set fixture for correct rotation (par. 81 **b**) and change controls to synchronization test.

(2) Start fixture and increase speed slowly until spark begins to advance. Reduce speed 75 to 150 revolutions per minute and set indicator to zero.

(3) Start fixture and increase speed until one degree advance is obtained then read speed. If speed is higher than specifications (par. 81 **c**) stop distributor and decrease tension on weak weight spring. Bend outer spring lug to change tension. If speed was too low increase tension on weak spring. On IAC 4003 distributor both springs are alike. When adjusting this distributor consider one spring as the weak spring and the other as the heavy spring.

(4) Check zero setting (par. 80 **d** (2) above) then recheck and readjust one degree point (par. 80 **d** (3) above).

(5) Increase distributor speed until advance is one degree less than maximum (par. 81 **c**) and read speed. If speed is too high or too low stop distributor and change strong spring tension by bending outer spring lug. Increasing tension increases speed at which advance occurs.

(6) Check advance at all points in specifications (par. 81 **c**) and make whatever readjustments are necessary to bring all points within one degree of specifications.

(7) Check the advance both up and down the speed range. If there is more than ½ degree difference in any one point it indicates friction in governor.

e. Complete the Assembly.

(1) Check to make sure all screws are lock-wired.

(2) Clean contacts with linen tape and carbon tetrachloride. Be sure no lint is left on contacts.

(3) Install seal plate in base and install three screws and lock washers. Lock-wire screws.

(4) Install rotor on shaft. Be sure rotor is pressed all the way down on shaft.

(5) Assemble cap gasket and cap on distributor. Install, tighten, and lock-wire two screws and lock washers.

DISTRIBUTORS—GROUP 2

81. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Cylinders—6

Control—Full automatic

Bearings—2 absorbent bronze.

Lubrication—At assembly add one drop of engine oil (SAE 30) to governor weight pivots and slots and soak bearings in oil (SAE 30). Saturate felt wick in shaft with oil (SAE 30). Apply one drop only of oil (SAE 30) to breaker arm hinge pin and remove excess oil. Fill grease cup with high temperature grease and turn down one complete turn. Do not over-lubricate distributor.

b. Mechanical.

Rotation

IAC 4001, 4002, 4002A—Left-hand when viewed from top.

IAC 4003—Right-hand when viewed from top.

Contact gap—0.018 to 0.022 inch. Set maximum gap to 0.020 inch.

Contact pressure—17 to 20 ounces.

Bearing diameter—new bearings

IAC 4001, 4002, 4002A—0.6245 to 0.6250 inch.

IAC 4003—0.4995 to 0.5000 inch.

Side play—new bearings and shaft—0.008 inch maximum.

Fit new bearings to 0.0005 inch maximum side play.

Side play—worn bearings and shaft—0.003 inch maximum.

End play—0.003 inch to 0.010 inch.

c. Electrical.

Cam dwell—38 degrees.

Condenser capacity—0.20 to 0.24 microfarads.

Maximum governor advance

IAC 4001, 4002, 4002A—12 degrees (distributor).

IAC 4003—10 degrees (distributor).

Governor advance curve

IAC 4001—CU 419

IAC 4002—CU 419

IAC 4002A—CU 845

IAC 4003—CU 191.

Advance Curves	CU 191	CU 419	CU 845
Start advance	0° at 300 RPM	0° at 350 RPM	0° at 425 RPM
One degree advance	1° at 410 RPM	1° at 370 RPM	1° at 450 RPM
Intermediate advance	5° at 850 RPM	3° at 400 RPM	4° at 525 RPM
Maximum less one degree	9° at 1,290 RPM	11° at 1,400 RPM	11° at 1,400 RPM
Full advance	10° at 1,400 RPM	12° at 1,530 RPM	12° at 1,525 RPM

(All figures are given in distributor degrees and RPM.)

CHAPTER 4

DISTRIBUTORS (Cont'd)

Section IV

DISTRIBUTORS—GROUP 3

82. DESCRIPTION AND DATA.

a. **Description** (fig. 120). Group 3 includes some full automatic distributors, some fully manual, and the balance are semi-automatic. The automatic type have governor control of the timing. The manual type has the timing controlled by a manually operated lever which is linked to the distributor and rotates the complete distributor in its mounting. Semi-automatic distributors have both types of control. Group 3 distributors differ slightly in construction from Groups 1 and 2 but the parts have the same general appearance and purpose. For model numbers of Group 3 generators, see paragraph 1.

b. **Data.**

Distributor	Rotation	Cylinders	Condenser* Capacity Mfd	Contact Gap Inches	Cam Dwell	Manual Advance	Governor Max	Advance Curve
IGW 4049	R.H.	2	0.20-0.25	0.020	111°	18°	...	....
IGW 4053	R.H.	2	0.20-0.25	0.020	111°	18°	...	....
IGW 4147	R.H.	6	0.20-0.25	0.020	35°	6°	10°	CU 191
IGW 4154	L.H.	6	0.20-0.25	0.020	35°	...	7°	CU 378
IGW 4165A	R.H.	2	0.20-0.25	0.020	....	...	15°	CU 782
IGW 4165B	R.H.	2	0.20-0.25	0.020	....	...	15°	CU 802

R.H.—Right hand rotation when viewed from top.
L.H.—Left hand rotation when viewed from top.
* Condenser located on outside of base.

Advance Curves

Advance Curve	0° Advance RPM	1° Advance RPM	Intermediate Advance	Intermediate RPM	Maximum less 1° Advance	Maximum less 1° RPM	Maximum Advance	Advance RPM
CU 191	300	410	5°	850	9°	1,290	10°	1,400
CU 378	400	540	3°	830	6°	1,260	7°	1,400
CU 782	300	330	7°	510	14°	720	15°	750
CU 802	300	340	7°	600	14°	880	15°	925
Tolerance	±50	±50	±1°	...	±1°	.....	±1°	.....

All figures in distributor RPM and distributor degrees.

83. CLEANING AND INSPECTING.

a. Cleaning.

(1) Wipe outside of distributor with cloth dampened in dry-cleaning solvent. Do not soak.

(2) Take out cover shield screws and lift off cover shield. Take out cap shield screws and lift off two sections of cap shield. Remove condenser mounting nut at end of condenser and remove condenser lead from terminal post. Take out screws or nut holding condenser shield to base. Lift off condenser and shield and remove condenser from shield.

(3) Snap off two cap clamp springs and lift off cap. Pull rotor from shaft being careful not to crack rotor. On IGW 4165A and IGW 4165B remove two screws holding cap cover to cap and lift off cover.

(4) Wipe cap, cap cover, rotor, condenser, and shielding, with cloth dampened in dry-cleaning solvent.

b. Inspecting.

(1) Discard cap if it is cracked, has corroded terminals or if carbon runners have formed either on inside or outside surfaces. Inspect contacts on inside of cap. After normal use these contacts become slightly burned on inside tip (fig. 106). If burning is excessive or uneven discard cap. If burning is found on horizontal face of contacts it indicates rotor is too short and must be replaced. Clean contacts with carbon tetrachloride but do not file. Replace cap if carbon contact in the center of the cap is cracked, stuck, or too short to contact rotor.

(2) Discard rotor if it is cracked, has loose contact strip, or if burning is found on top of strip. Inspect end of contact. If burning is excessive discard rotor. If burning is only slight clean with carbon tetrachloride. Do not file.

(3) Inspect shielding for loose couplings, dents, and stripped threads. Discard if these conditions are found.

84. DISASSEMBLY.

a. Remove Advance Arm.

(1) With straightedge and sharp point mark relationship between arm and base.

(2) Loosen clamp screw and slide arm and large thrust washer off base.

b. Remove Condenser. Take out mounting screw and lock washer. Remove nut, lock washer, and condenser lead from terminal stud and lift off condenser.

c. Remove Breaker Arm. Remove nut from terminal stud and take off washers. Lift breaker arm from pivot.

d. Remove Terminal Stud. Press stud out of base. Remove bushing, contact arm insulation, and square washer.

e. Remove Breaker Plate (if pertinent). Remove three screws and lock washers. Cap clamp springs will come off with screws. Lift out breaker plate.

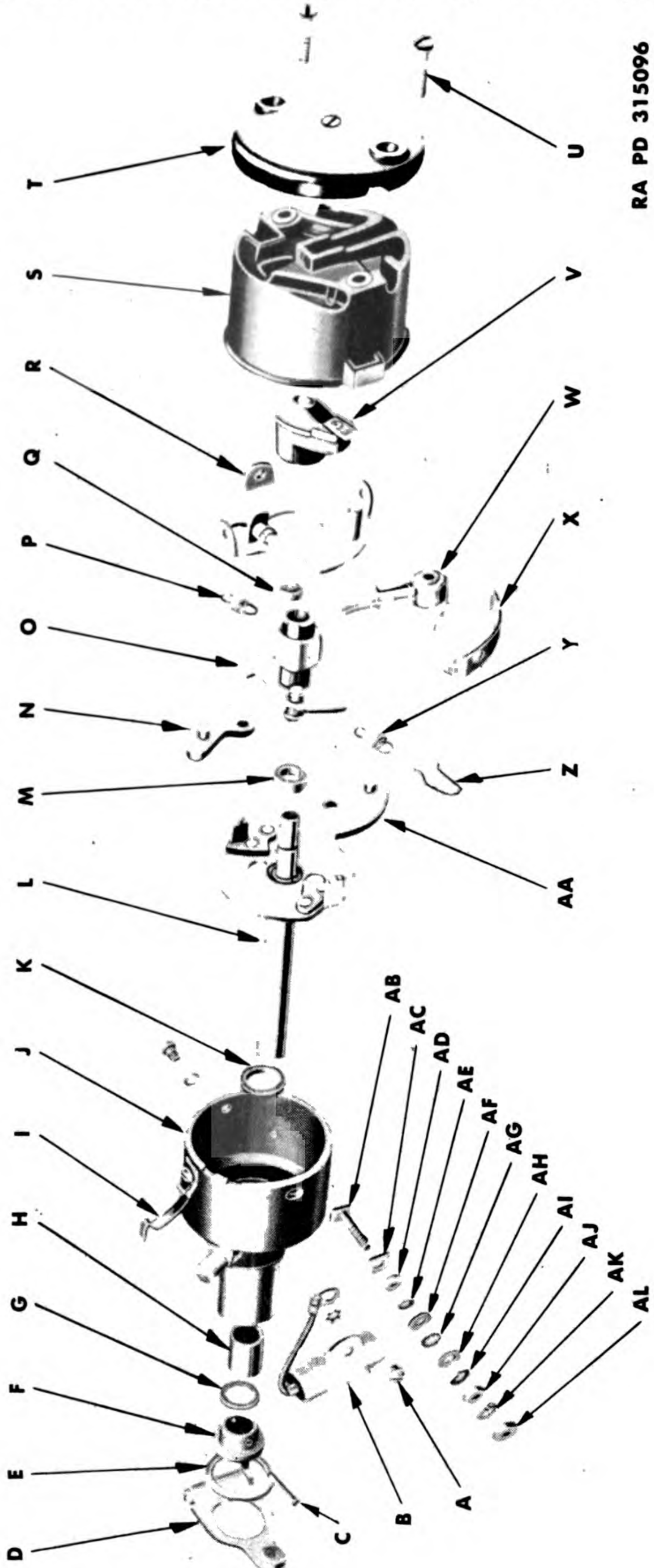

Figure 120—Components of Group 3 Distributors

f. Remove Cap Clamp Springs (manual type only). Take out screws and lock washers and lift off clamp springs.

g. Remove Stationary Contact Bracket (manual type only). Take out two screws and lift off.

h. Remove Stationary Contact. Unscrew contact from bracket.

85. CLEANING OF COMPONENTS.

a. Breaker Plate. Dip plate in dry-cleaning solvent. Dry thoroughly with clean dry compressed air.

b. Terminal Stud, Cap Clamp Springs, and Small Metal Parts. Soak in dry-cleaning solvent and clean and dry thoroughly.

A—CONDENSER MOUNTING SCREW
B—CONDENSER
C—DRIVE COUPLING RIVET
D—ADVANCE ARM
E—LARGE THRUST WASHER
F—DRIVE COUPLING
G—LOWER THRUST WASHER
H—DRIVE SHAFT BEARING
I—CAP CLAMP SPRING
J—BASE ASSEMBLY
K—UPPER THRUST WASHER
L—DRIVE SHAFT
M—CAM SPACER
N—GOVERNOR WEIGHT
O—CAM
P—GOVERNOR SPRING
Q—FELT WICK
R—BREAKER PLATE
S—CAP ASSEMBLY
T—CAP COVER
U—CAP COVER SCREW
V—ROTOR
W—BREAKER ARM
X—BREAKER ARM INSULATION
Y—GOVERNOR SPRING
Z—CAM LOCK RING
AA—GOVERNOR WEIGHT
AB—TERMINAL POST
AC—SQUARE STEEL WASHER
AD—INSULATING WASHER
AE—INSULATING BUSHING
AF—INSULATING WASHER
AG—SHAKEPROOF LOCK WASHER
AH—PLAIN WASHER
AI—LOCK WASHER
AJ—NUT
AK—LOCK WASHER
AL—NUT

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Legend for Figure 120—Components of Group 3 Distributors

c. Insulating Parts. Dip in dry-cleaning solvent and clean and dry thoroughly. Do not soak.

d. Contacts. Dip in dry-cleaning solvent and blow off with clean dry compressed air. Rub contact face with clean linen tape. Be sure no lint is left on contacts.

e. Base, Shaft, Governor, and Cam. Wipe as clean as possible with rag dampened in dry-cleaning solvent. Do not soak. Blow dry with clean, dry, compressed air.

86. INSPECTION AND TEST OF COMPONENTS.

a. Breaker Plate.

(1) Inspect for distortion, stripped threads, loose contact bracket, and loose pivot pin. Discard plate if these conditions are found.

(2) Install breaker arm on pivot. It must turn freely without

binding or looseness. Remove arm and inspect pivot. Install new plate if wear is evident on pivot or if pivot is not perpendicular to plate.

b. Condenser. Test condenser for capacity and grounds on condenser tester. Install new condenser if it is grounded, leaky or if the capacity is not between 0.20 and 0.25 microfarads. Inspect lead and discard condenser if lead is broken or if insulation is worn.

c. Insulating Parts. Replace insulation if cracked or oil soaked.

d. Miscellaneous Parts. Discard terminal stud if stripped or if it cannot be cleaned up to give good electrical contact. Discard cap clamp springs if bent, distorted, or if badly corroded or rusted. Replace screws and washers if stripped or cracked.

e. Contacts. If contacts are a grayish color and are not pitted or burned, they need not be replaced. Discard contacts if they are rough, burned, or pitted, or if contact arm does not fit pivot pin without looseness or binding.

f. Base, Shaft, Governor, and Cam.

(1) Note relationship between distributor drive tongue and cam. Make a sketch to facilitate reassembly.

(2) Slip governor weight springs off lugs on weight carrying plate. Remove springs.

(3) Remove felt wick from top of cam. Take off cam retaining snap ring. Lift off cam and governor weights.

(4) Inspect weight pivots and pivot holes for wear. Replace cam or weights if weights are loose on pivots.

(5). Discard governor springs if they are bent or distorted.

(6) Install new shaft (par. 87 **b** and **c**) if weight carrying plate is bent or if spring lugs are broken.

(7) Install new gear or coupling (par. 87 **b** and **c**) if teeth are worn excessively or if damaged.

(8) Replace cam if lobes are worn excessively or are grooved. Inspect weight stop plate for wear and replace cam if this wear is enough to interfere with weight movement. On manual type distributors it is necessary to install new shaft (par. 87 **b** and **c**) to replace cam.

(9) Clamp dial indicator on base with plunger against side of shaft. Apply a five pound pull to shaft in line with indicator and read total side play (fig. 111). Install new drive shaft bearings (par. 87 **b** and **c**) if side play is more than 0.005 inch.

(10) Clamp dial indicator on base with plunger against end of shaft. Move shaft to its two extreme positions and read total end play. End play can also be measured with flat feeler gage inserted between bottom of base and lower thrust washer (fig. 112). If end play is less than 0.003 inch tap lower end of shaft to increase end play. If end play is more than 0.010 inch remove drive gear, coupling or collar (par. 87 **b** and **c**) and install additional thrust washers between base and gear.

(11) Inspect base and replace (par. 87 **b** and **c**) if cracked or if threads are stripped.

(12) Install new oiler or grease cup if damaged.

87. REPAIR AND REBUILDING OF COMPONENTS.

a. Miscellaneous Parts. There are no repairs of the breaker plate, terminal stud, cap clamp springs, insulation, contacts, condenser, governor weights, springs, or cam, other than complete replacement.

b. Base, Shaft, Gear, Collar, Coupling, or Bearing Removal. Note relationship between tongue on coupling and weight carrying plate. Remove rivet and take gear, collar or coupling off shaft. Take off lower thrust washer and remove bur from rivet hole in shaft. Pull shaft out of base and remove upper thrust washer. Drive old bearings out of base with arbor or bolt that rests on bearing without gouging bearing bore.

c. Base, Shaft, Gear, Collar, Coupling, or Bearing Assembly.

(1) Install new bearings on arbor of 0.5-inch diameter and press bearings into place. Install lower bearing flush with bottom of base and install upper bearing 0.094 inch below face of bearing bore. Drill oil hole through bearing with drill of same diameter as oil hole in base. Remove bur from inside of bearing being careful not to mar bearing.

(2) Soak bearings in medium engine oil and remove excess oil. Do not get oil in upper part of base.

(3) Install upper thrust washer on shaft and place shaft in base. Install lower thrust washer and gear, collar or coupling on shaft. Turn coupling so drive tongue is in correct relation to weight carrying plate (par. 87 **b** above). Drill rivet hole through shaft to correspond to rivet hole in gear, collar, or coupling. Install rivet and swage so both ends are riveted over and so pin swells to fill hole.

(4) Check end play (par. 86 **f** (10)).

88. ASSEMBLY.

a. Assemble Governor (if pertinent). Place spacing washer on shaft with chamfered side down and place weights in position on weight carrying plate. Install cam on shaft so pins enter holes in weights. Hold cam in position and inspect relation of cam and drive tongue. If relationship is not as noted in paragraph 86 **f** (1) lift cam and turn 180 degrees, then install. Install cam lock ring. Install felt wick in top of cam.

b. Lubrication. Soak felt in top of cam with engine oil (SAE 30). Lubricate governor mechanism sparingly with engine oil (SAE 30). Apply thin film of engine oil (SAE 10) to breaker arm hinge pin and wipe off excess oil. Apply light film of high temperature grease to breaker cam. Add three to five drops of engine oil (SAE 30) to oiler on side of base. Fill grease cup with high temperature grease and turn down one turn after air is expelled. Do not over-lubricate.

c. Install Stationary Contact. On manual type distributors, install contact bracket on base and fasten with two screws and lock washers. Install lock nut on contact screw and install contact in bracket.

d. Install Breaker Plate (if pertinent). Place plate in base. Install three screws and lock washers and two cap clamp springs.

e. **Install Cap Clamp Springs** (manual type). Install clamp springs on base and fasten with two screws and lock washers.

f. **Install Terminal Stud.** Assemble square washer, insulating washer, and contact arm insulation, on stud and install stud in base. Install insulating bushing, insulating washer, toothed lock washer, condenser terminal, plain washer, lock washer, and nut on stud. Do not tighten.

g. **Install Condenser.** Install condenser on base. Install screw and toothed lock washer. Washer must be inside condenser bracket. On shielded types do not mount condenser until after adjustments.

h. **Install Breaker Arm.** Place breaker arm on pivot pin and install spring and connector between head of terminal post and square washer. Tighten terminal post nut.

89. TESTS AND ADJUSTMENTS.

a. **Adjust Contact Gap.**

(1) Turn shaft so breaker arm rubbing block is on a high point of cam.

(2) Loosen stationary contact lock nut. Adjust contact gap to 0.020 inch by screwing stationary contact in or out (fig. 115). Use wire feeler gage to check contact gap as there is less chance for error than with flat gage. Tighten lock nut (fig. 116) being careful not to turn contact screw.

(3) Turn shaft so contacts are closed. Inspect contact alinement. Bend stationary contact bracket so contacts are alined for full face contact.

(4) Adjust contact gap (par. 89 a (1) and (2) above).

b. **Adjust Contact Pressure.** Hook spring scale on contact arm at contact and pull on a line with contacts (fig. 117). Take reading just as contacts separate. Adjust tension to 17 to 20 ounces by loosening terminal post nut and sliding spring in or out as necessary. Tighten nut and check pressure.

c. **Adjust Cam Dwell.**

(1) Mount distributor on test fixture and connect test leads. Set fixture for correct rotation (par. 82 b). On shielded types ground condenser case to distributor base with short lead.

(2) Start fixture and operate at about 1,000 distributor revolutions per minute. Read cam dwell. Adjust to figure specified (par. 82 b) by loosening contact lock nut and screwing contact screw in or out as necessary. Tighten lock nut and check dwell.

d. **Adjust Governor** (if pertinent).

(1) With distributor mounted on fixture (par. 89 c), set controls for synchronization test.

(2) Start fixture and increase speed slowly until the spark just begins to advance. Reduce speed 75 to 150 revolutions per minute and set indicator to zero.

(3) Start fixture and increase speed until one degree advance is obtained then read speed. If speed is not as specified (par. 82 b) stop

distributor. If speed was too high decrease tension on weak weight spring by bending outer spring lug. If speed was too low increase tension on weak spring. On distributors with both springs alike consider one spring as weak spring and other as a heavy spring and make adjustments as described.

(4) Check zero setting then check and adjust one degree point (par. 89 **d** (2) and (3) above).

(5) Increase distributor speed until advance is one degree less than maximum (par. 82 **b**) and read speed. If speed is too high or too low stop distributor and change strong spring tension by bending outer spring lug. Increasing tension increases speed at which advance occurs.

(6) Check advance at all points in specifications and make whatever adjustments necessary to bring all points within tolerance in specifications (par. 82 **b**).

(7) Check advance both up and down speed range. If there is more than ½ degree difference in any one point it indicates friction in governor.

e. Complete the Assembly.

(1) Clean contacts with linen tape and carbon tetrachloride. Be sure no lint is left on contacts.

(2) Install rotor on shaft. Be sure rotor is pressed down on shaft.

(3) Install cap on distributor. Turn cap so projection fits into slot and snap cap clamp springs into place. Install cap cover, if pertinent.

(4) Install second lock washer and nut on terminal post.

(5) Install cap shielding to base and fasten with holding screws. Install condenser in shield and install mounting lock washer and nut. Fasten condenser shield to distributor.

90. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Cylinders—(see tabulation) (par. 82 **b**).

Control—Manual, semi-automatic, or full automatic.

Bearings—Two absorbent bronze bearings in lower part of base.

Lubrication—At assembly lubricate governor mechanism sparingly with engine oil (SAE 30) and saturate cam sleeve felt wick with engine oil (SAE 30). Add one drop only of engine oil (SAE 10) to breaker arm pivot pin and remove excess oil. Apply a light film of high temperature grease to breaker cam. Add three to five drops of engine oil (SAE 30) to oiler at side of base. Fill grease cup with high temperature grease and turn down one complete turn. Do not over-lubricate.

b. Mechanical.

Rotation—(see tabulation) (par. 82 **b**).

Contact Gap—0.018 inch to 0.022 inch. Set maximum gap to 0.020 inch.

Contact Pressure—17 to 20 ounces.

Bearing diameter (new bearings)—0.4995 to 0.5000 inches.

Side Play (new bearings and shaft)—0.001 inch maximum. (fit new bearings to 0.0005 inch maximum side play.)

Side Play (worn bearings and shaft)—0.005 inch maximum.

End Play—0.003 inch to 0.010 inch. Measure after gear, collar, or coupling is pinned in place.

c. Electrical.

Cam dwell—(see tabulation) (par. 82 **b**).

Condenser capacity—0.20 to 0.25 microfarads.

Maximum governor advance—(see tabulation) (par. 82 **b**).

Governor advance curve—(see tabulation) (par. 82 **b**).

Manual advance—(see tabulation (par. 82 **b**).

d. Tabulated Specifications (par. 82 **b**).

CHAPTER 5

CRANKING MOTORS

Section I

CRANKING MOTORS—BASIC PRINCIPLES

91. DESCRIPTION.

a. Construction.

(1) The cranking motor consists of five main subassemblies which are: the frame and field, the armature, the commutator end head, the drive end head or pinion housing, and the drive clutch. The armature and frame and field are similar in construction and purpose to the generator parts except the windings are heavier to carry the larger currents encountered. The commutator end head supports a bearing, four brush holders, and brushes. The pinion housing is a cast iron or bronze housing for the drive clutch and also provides the motor mounting lugs. Some motors use a drive end head which takes the place of the pinion housing but does not enclose the drive clutch. The drive clutch operates automatically to engage the cranking motor with the engine flywheel when the motor cranks the engine, and disengages it when the engine starts.

(2) Two types of starter clutches are used (fig. 121), the Bendix drive, and the overrunning clutch. The Bendix drive consists of a threaded sleeve fastened to the armature shaft through a drive spring and a pinion mounted on the threads of the sleeve. When the starting circuit is closed the armature revolves, turning the sleeve within the pinion, and forces the gear forward meshing it with the flywheel gear. The sudden shock of meshing is absorbed by the spring. When the engine starts the pinion is driven faster than the sleeve and is forced back along the threads, automatically demeshing it from the flywheel. The overrunning clutch type of drive consists of a pinion connected by a roller clutch to a sleeve. The sleeve has internal splines that match splines on the armature shaft. To engage the flywheel the whole clutch is shifted along the armature shaft either by starter pedal linkage or by solenoid action. The starting switch is designed to close when the meshing is nearly completed. When the motor cranks the engine, the clutch binds the pinion to the sleeve in a firm grip and transmits the torque to the flywheel. When the engine starts the clutch releases and allows the pinion to turn faster than the sleeve. This prevents spinning the armature. When the starter pedal or button is released spring action disengages the pinion from the flywheel.

b. General.

(1) Cranking motors differ as to the design of the above parts due

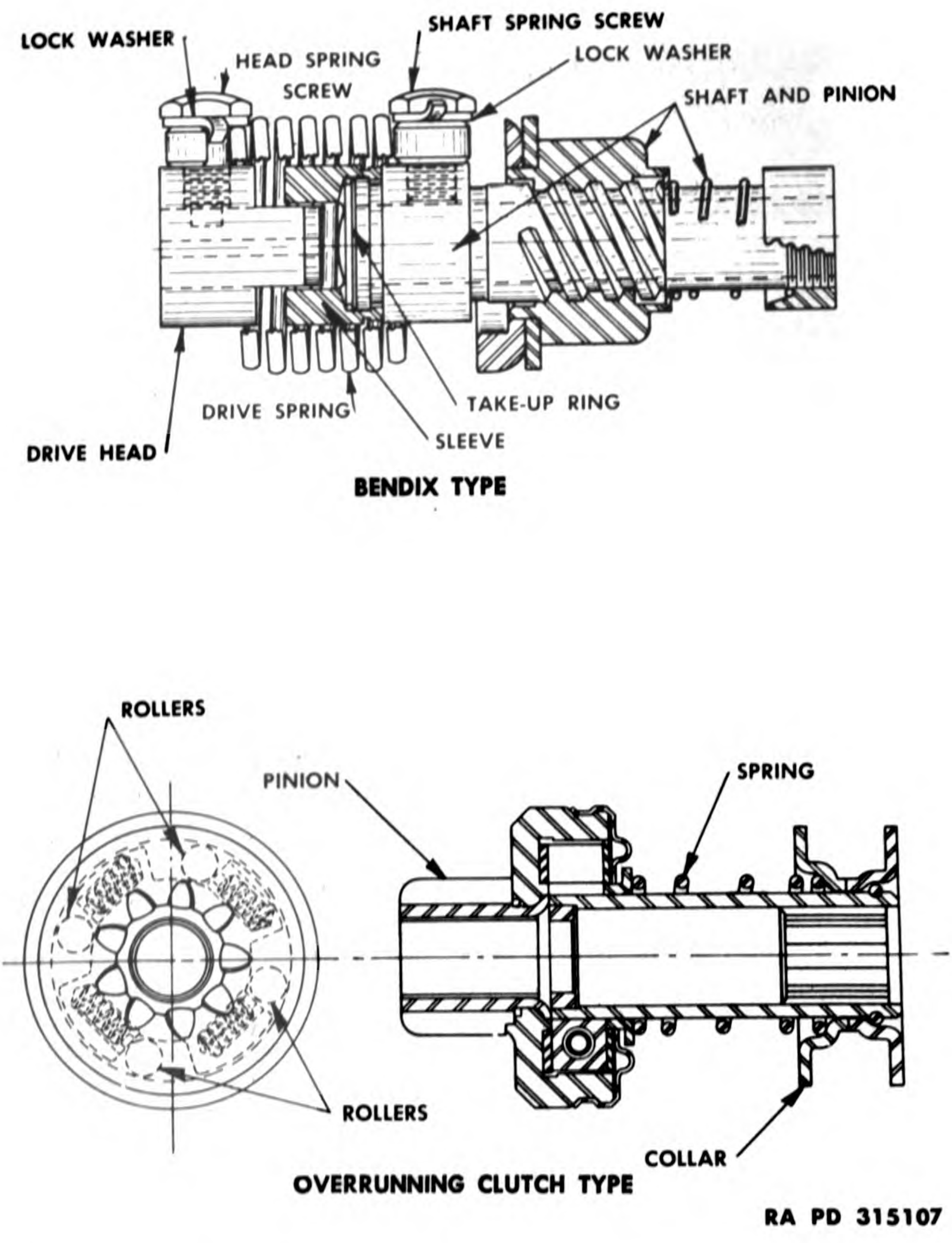


Figure 121—Sectional Drawing of Cranking Motor Clutches

to the different electrical and mechanical characteristics desired for particular installations. The size, type mounting, type of drive or the voltage, current and torque ratings differ but all include the major components just described.

(2) Cranking motor part numbers are stamped on the name plate which is riveted to the frame or head band. All reference to individual units is made according to this part number.

92. THEORY AND OPERATION.

a. Theory. Torque is developed when a current carrying conductor enters a magnetic field. The amount of torque depends upon the values of the field and current and on the number of conductors.

b. Operation. When the starting switch is closed current flows through the field coils and through the armature coils. The torque produced by these currents is transmitted to the armature which revolves. To offset the reversal in the direction of the torque every time a conductor passes poles of different polarity, the commutator and brushes act to reverse the direction of current in the armature conductors. This results in all conductors producing torque in the same direction. The torque is transmitted from the armature to the engine flywheel by the Bendix drive or overrunning clutch previously described (par. 91 a (2)).

CHAPTER 5

CRANKING MOTORS (Cont'd)

Section II

CRANKING MOTORS—GROUP 1

93. DESCRIPTION AND DATA.

a. **Description** (figs. 122 and 123). Group 1 cranking motors are four-pole, four-brush units. The brushes are mounted in box-type holders with the brush springs bearing directly on the brushes. Two of the brushes are soldered to the field coil windings while the other two are grounded either to the commutator end head or to the frame. For model numbers of Group I cranking motors, see paragraph 1.

b. **Data.**

Rotation—Clockwise at the drive end.
Brush Spring Tension—42 to 53 ounces with new brushes.
End Play—Bendix type motors—$\frac{1}{16}$ inch maximum.
Overrunning clutch type motors—0.005 to 0.030 inch.

Cranking Motor	Rated Volts	No Load Volts	No Load Max Amps	No Load Min RPM	Stall Torque Volts	Stall Torque Max Amps	Stall Torque Min Ft Lbs	Type of Clutch
MAB 4071	6	5.5	60	3,700	3.0	582	15.8	Bendix
MAB 4082	6	5.5	60	3,700	3.0	582	15.8	Bendix
MAU 4006	12	11.0	65	4,800	6.0	540	17.3	Bendix
MAW 4029	6	5.5	65	4,900	3.0	505	11.5	Overrunning
MAX 4041	6	5.5	77	2,695	3.0	652	33.5	Overrunning
MAY 4114A	12	11.0	30	5,300	6.0	285	13.2	Overrunning
MAY 4114B	12	11.0	30	5,300	6.0	285	13.2	Overrunning
MAY 4132	12	11.0	30	5,300	6.0	285	13.2	Overrunning
MAY 4133	12	11.0	30	5,300	6.0	285	13.2	Overrunning
MAY 4137	12	11.0	30	5,300	6.0	285	13.2	Bendix
MAY 4138	12	11.0	30	5,300	6.0	285	13.2	Bendix
MAY 4141	12	11.0	30	5,300	6.0	285	13.2	Overrunning
MBY 4001	24	20.0	20	4,200	12.0	180	15.0	Bendix
MZ 4059	6	5.5	70	4,300	3.0	420	7.8	Overrunning
MZ 4059A	6	5.5	70	4,300	3.0	420	7.8	Overrunning
MZ 4089A	6	5.5	70	4,300	3.0	420	7.8	Overrunning
MZ 4113	6	5.5	70	4,300	3.0	420	7.8	Bendix
MZ 4115	6	5.5	70	4,300	3.0	420	7.8	Overrunning

94. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Wipe outside of motor with cloth dampened in dry-cleaning solvent. Do not allow dry-cleaning solvent to enter motor.

(2) Loosen cover band clamp screw and slide band from motor.

(3) Hold 2/0 flintpaper against commutator and turn armature slowly until commutator is clean. Blow sand and dust from commutator and brushes with clean dry compressed air.

b. Inspecting.

(1) Inspect frame, pinion housing, or drive end head and commutator end head for cracks. Disassemble and overhaul (pars. 95 to 100) if cracks are found. If commutator end head is not perfectly flat disassemble motor and install new head (pars. 95 to 100). Install new Bendix pinion if cracked, broken, or unevenly worn (pars. 95 to 100).

(2) Lift brush spring and remove brushes from holders (fig. 124). Blow off brushes and holders with clean dry compressed air. If brush holders are dirty, gummy, or corroded, overhaul motor (pars. 95 to 100). If brushes are oil soaked or are worn to less than $\frac{5}{16}$ inches long overhaul motor and install new brushes (pars. 95 to 100). Hold brush spring up with hook and try the fit of brushes in holders. If brushes do not slide freely overhaul motor. Install brushes in their holders and inspect brush alinement on commutator. If edges of brushes are not in perfect alinement with commutator segments overhaul motor (pars. 95 to 100).

(3) Inspect commutator. If commutator is an even brown color without burns or grooves it needs no attention. If commutator is rough, worn or burned overhaul motor (pars. 95 to 100).

(4) Hold armature and turn Bendix pinion. It must move out along shaft without restrictions other than antidrift spring. When pinion reaches the stop it must lock to the armature shaft. If Bendix does not act in this manner or if any doubt exists as to condition of Bendix drive, disassemble motor and inspect further (pars. 95 to 100).

(5) On clutch-type motors shift yoke lever by hand. Clutch must move along shaft easily and smoothly without binding. Hold armature and turn pinion clockwise at drive end. Clutch must release and pinion must turn smoothly though not necessarily freely. Reverse direction of rotation of pinion, clutch must instantly lock. Overhaul motor (pars. 95 to 100) and inspect clutch further if it does not act as described.

(6) Inspect switch to see that it is mounted firmly and that all linkage or moving parts operate without binding. Overhaul motor (pars. 95 to 100) if linkage does not operate properly and refer to paragraphs 130 through 139 if any doubt exists as to switch condition.

c. Testing.

(1) MEASURE END PLAY. Mount indicator (41-I-100) on motor with plunger against end of shaft (fig. 125). Move armature to its two extreme positions and read total indicator reading. If end play is not

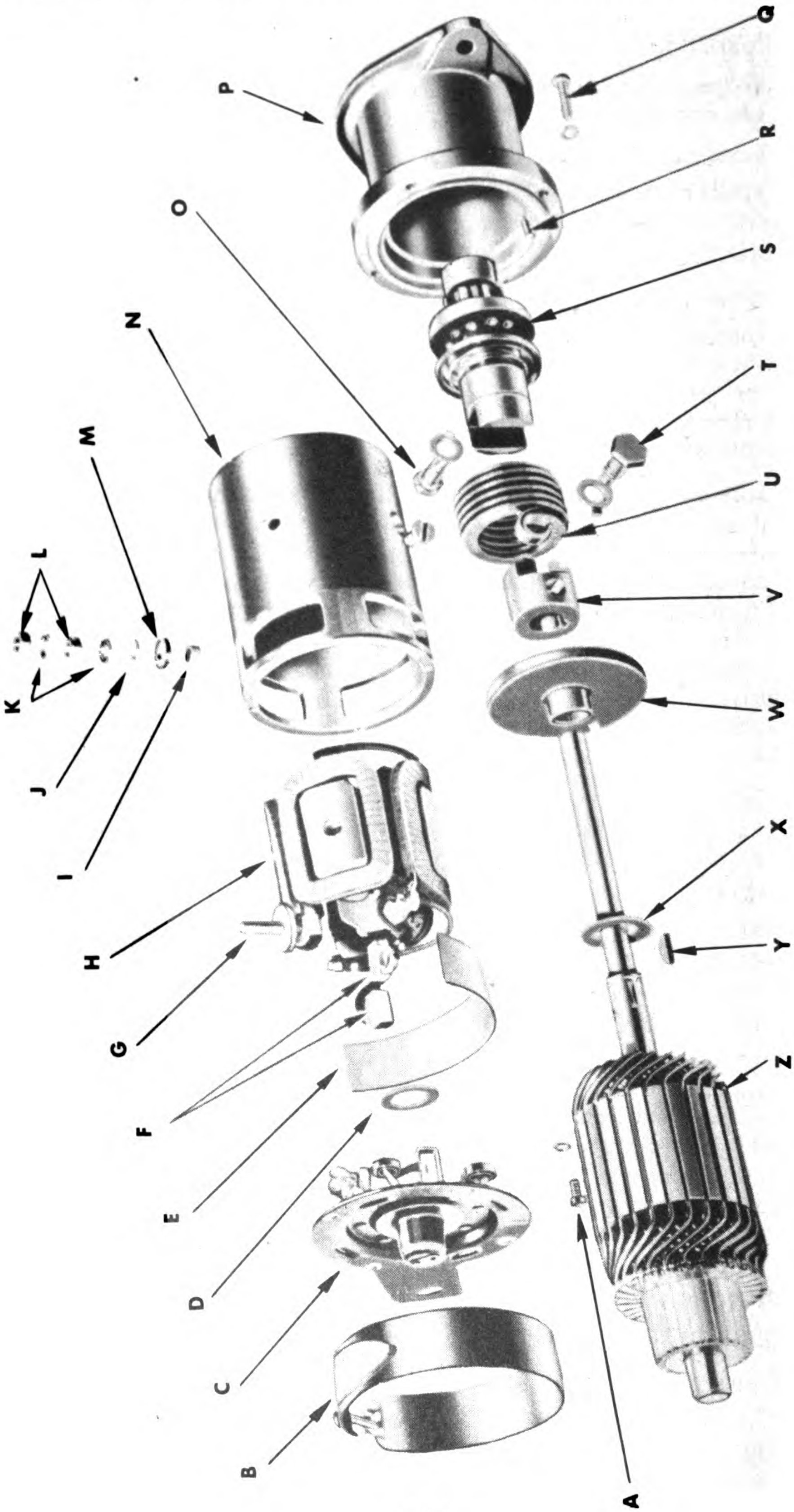


Figure 122—Main Components of Group 1 Motors Using Bendix Drive Clutch, Partially Disassembled

within limits (par. 93 b) overhaul motor and look for improper assembly (pars. 95 to 101). Install thrust washers on commutator end of shaft to bring end play within limits.

(2) MEASURE PINION CLEARANCE.

(a) On Bendix types measure clearance between Bendix drive stop and outer pinion housing bearing bore (fig. 126). If this clearance is more than 1/16 inch overhaul motor (pars. 95 to 100) and install thrust washers on commutator end of armature shaft.

(b) On clutch type motors shift pinion until switch plunger bot-

A—COMMUTATOR END HEAD ATTACHING SCREW
B—COVER BAND
C—COMMUTATOR END HEAD
D—COMMUTATOR END THRUST WASHER
E—FIELD CONNECTION INSULATION
F—INSULATED BRUSHES
G—TERMINAL STUD
H—FIELD COILS AND POLE SHOES
I—TERMINAL POST INSULATING BUSHING
J—TERMINAL POST PLAIN WASHER
K—TERMINAL POST LOCK WASHER
L—TERMINAL POST NUT
M—TERMINAL POST INSULATING WASHER
N—FRAME
O—BENDIX SHAFT SPRING SCREW
P—PINION HOUSING
Q—PINION HOUSING ATTACHING SCREW
R—DOWEL PIN
S—BENDIX SHAFT AND PINION
T—BENDIX HEAD SPRING SCREW
U—BENDIX DRIVE SPRING
V—BENDIX HEAD
W—INTERMEDIATE BEARING
X—INTERMEDIATE THRUST WASHER
Y—WOODRUFF KEY
Z—ARMATURE

RA PD 315125B

Legend for Figure 122—Main Components of Group 1 Motors Using Bendix Drive Clutch, Partially Disassembled

toms. On solenoid type press on solenoid plunger and not on yoke arm. Measure clearance between pinion and drive end thrust washer. If this clearance is not between 1/16 and 3/32 inch it indicates improper linkage adjustment. Adjust clearance to 1/16 to 3/32 inch by screwing plunger link screw in or out on solenoid type or by screwing switch plunger in or out on manual type. Disconnect linkage on solenoid type or press plunger spring out of slot on manual type in order to make this adjustment.

(3) MEASURE NO-LOAD DRAW AND SPEED (fig. 127).

(a) Connect 100-ampere ammeter, carbon pile rheostat and battery of rated voltage (par. 93 b) in series with motor terminal stud and

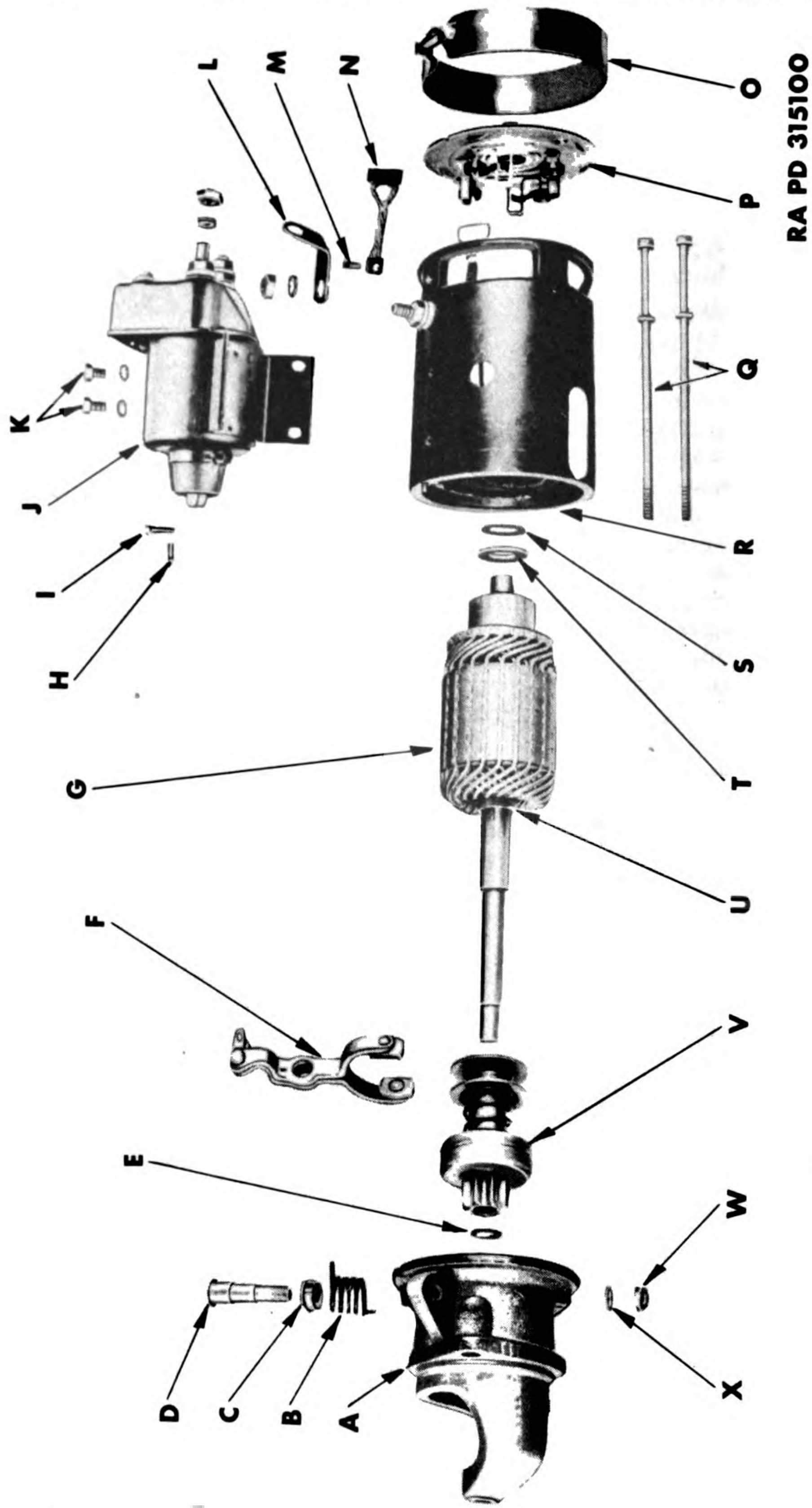


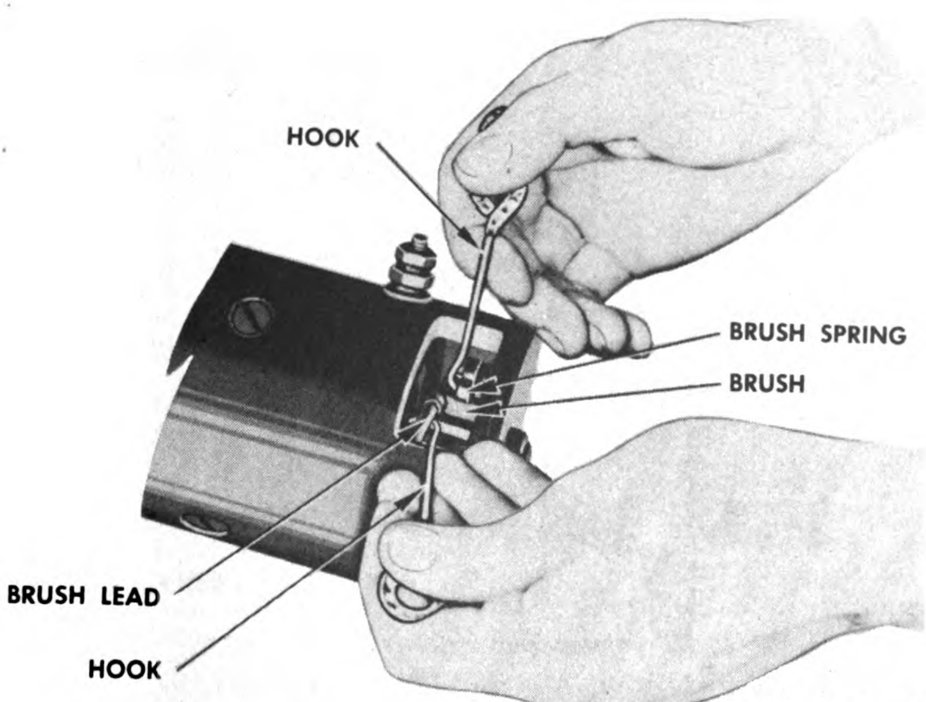
Figure 123—Main Components of Group 1 Motors Using Overrunning Clutch, Partially Disassembled

A—PINION HOUSING
B—YOKE SPRING
C—YOKE BUSHING
D—YOKE PIVOT
E—THRUST WASHER
F—YOKE
G—ARMATURE
H—COTTER PIN
I—YOKE LINK PIN
J—SOLENOID SWITCH
K—SWITCH MOUNTING SCREWS
L—SWITCH TO MOTOR CONNECTOR
M—BRUSH ATTACHING SCREW
N—GROUNDED BRUSH
O—COVER BAND
P—COMMUTATOR END HEAD
Q—THROUGH BOLTS
R—FRAME AND FIELD ASSEMBLY
S—STEEL THRUST WASHER
T—FIBRE THRUST WASHER
U—SPACER
V—OVERRUNNING CLUTCH
W—YOKE PIVOT NUT
X—YOKE PIVOT LOCK WASHER

RA PD 315100B

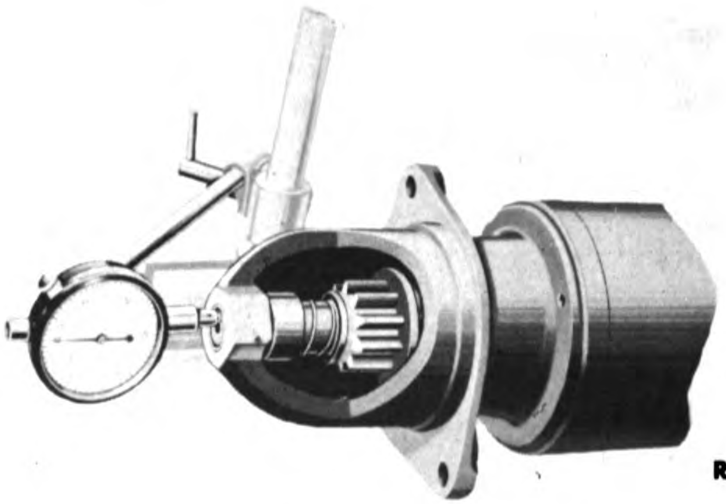
Legend for Figure 123—Main Components of Group 1 Motors Using Overrunning Clutch, Partially Disassembled

motor frame. Connect voltmeter from motor terminal stud to frame. It is not necessary to remove switch but do not include solenoid switch in circuit. On manual clutch type motors connect to switch terminal rather than motor terminal as latter is inaccessible. Close test stand battery switch and, on manual clutch type motors, close motor switch. Adjust voltage to specified value (par. 93 **b**) and read ammeter. Hold hand tachometer against drive end of armature shaft while operating at specified voltage. If current is higher than specified value or if



RA PD 315119

Figure 124—Removing Brushes from Holders on Group 1 Motors



RA PD 315123

Figure 125—Measuring Armature End Play with Indicator (41-I-100)

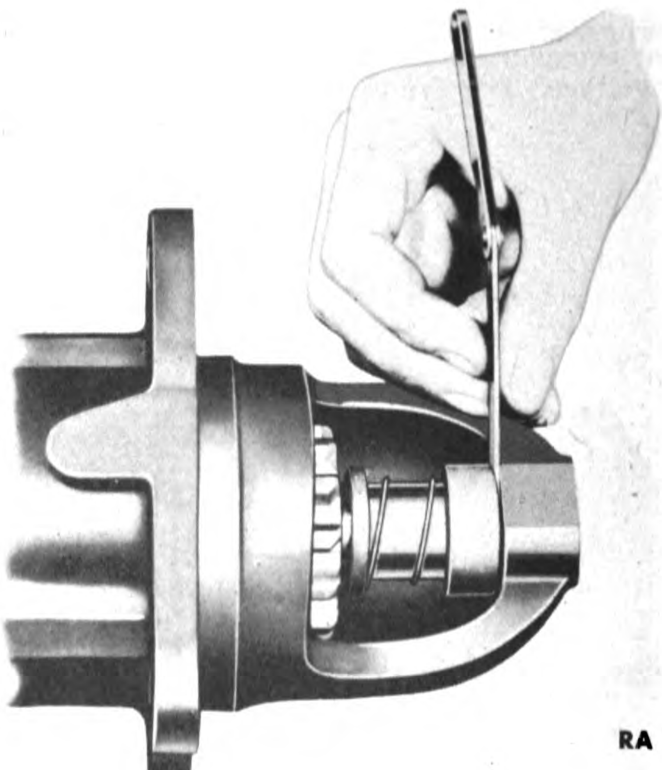


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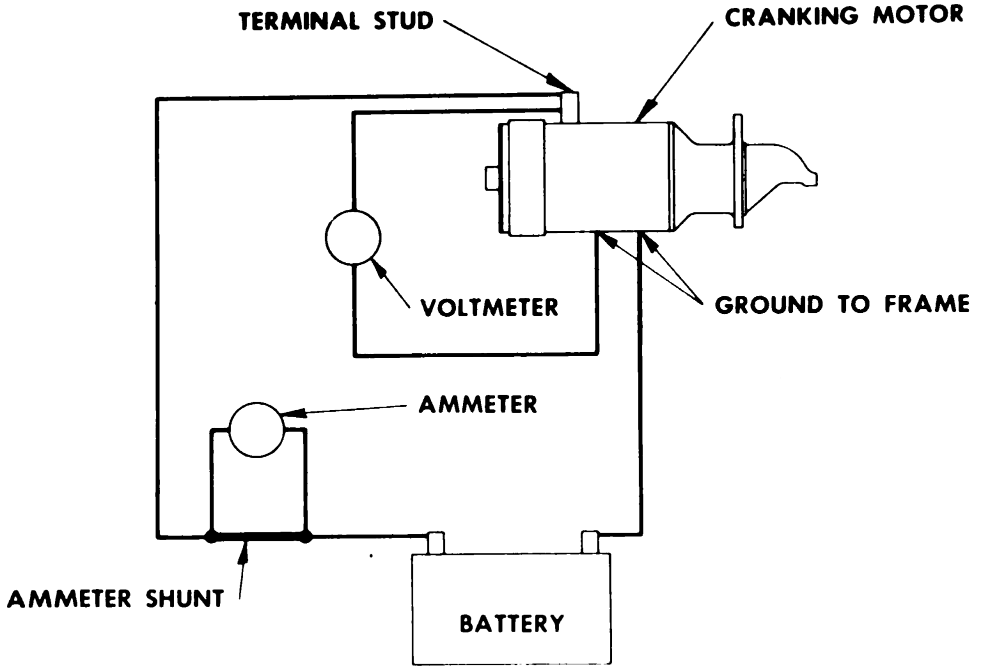
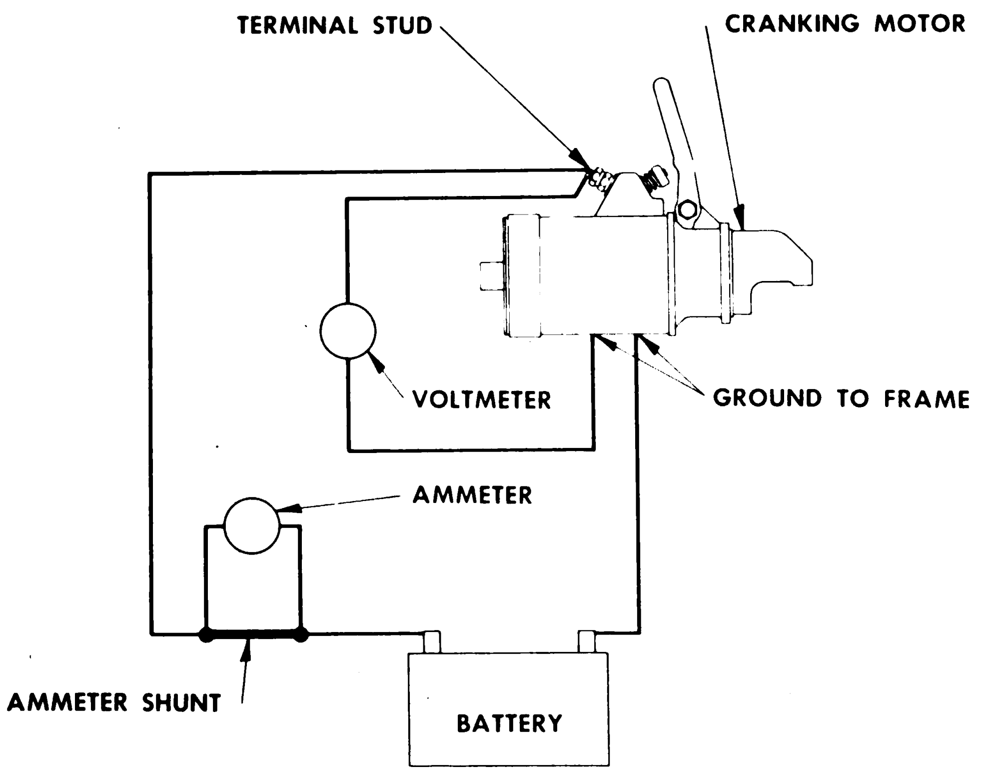
Figure 126—Measuring Clearance Between Bendix Stop and Pinion Housing with Thickness Gage (41-G-400)



TEST HOOKUP FOR MOTORS WITH SEPARATE SWITCH OR WITH SOLENOID SWITCH



TEST HOOKUP FOR MOTORS WITH MANUAL SWITCH MOUNTED ON MOTOR

RA PD 315131

Figure 127—Cranking Motor Test Hookups

speed is low, overhaul motor (pars. 95 to 100) and look for evidences of binding on armature and for shorts within motor. If current and speed are both low, overhaul motor (pars. 95 to 100) and look for high resistance connections at terminal stud, field coils, brushes, and switch.

(b) On Bendix types inspect pinion while operating at no load. If

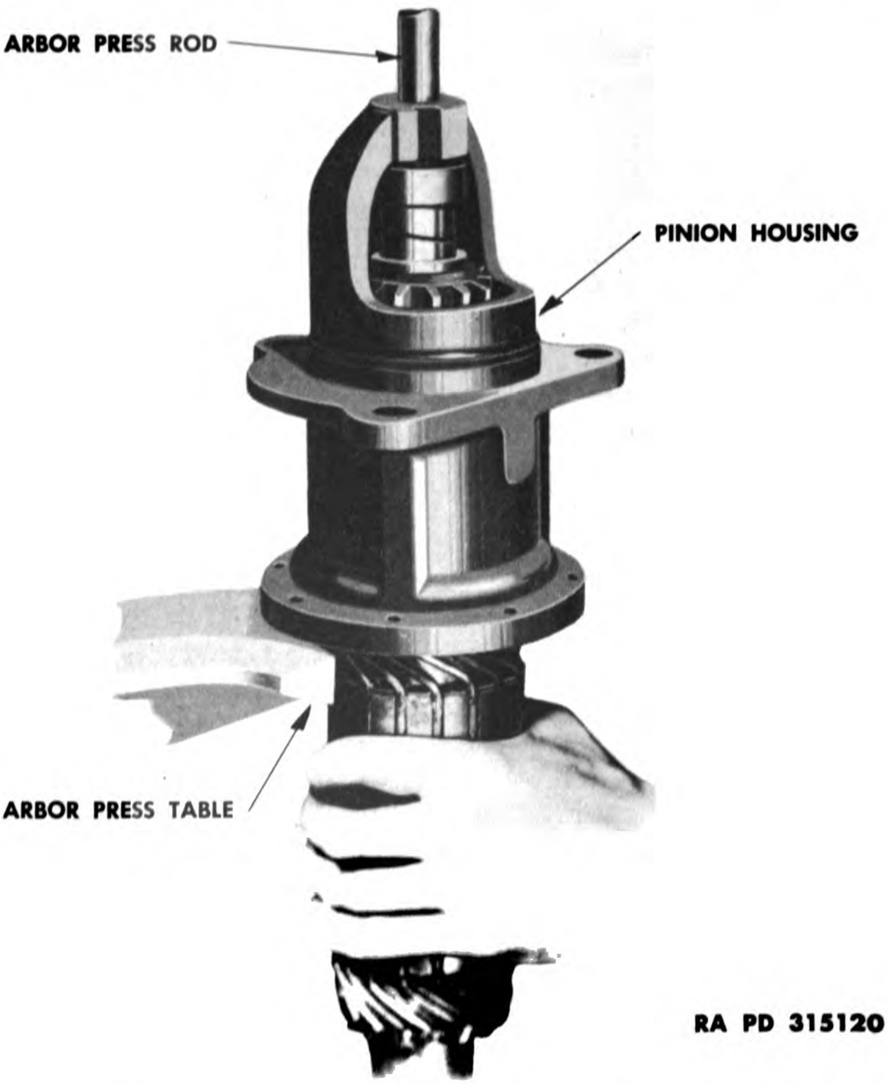


Figure 128—Pressing Armature Out of Pinion Housing with Arbor Press

pinion does not shift when motor is started and stopped, overhaul motor (pars. 95 to 100) and inspect Bendix.

(4) MEASURE STALL CURRENT AND TORQUE. With motor connected as in no load test (par. 94 c (2) above) clamp motor down and mount torque arm and spring scale on motor. Close test stand battery switch and motor switch, if in the circuit, and adjust voltage to figure specified (par. 93 b). Read ammeter and spring scale. Multiply

spring scale reading by length of torque arm to get stall torque. If current is high and torque low it indicates shorts or improper assembly of motor. If current and torque are both low it indicates high resistance in internal connections at field coils, armature, brushes or switch. Overhaul motor (pars. 95 to 100) if stall torque and current are incorrect and look for above conditions.

(5) CHECK SOLENOID SWITCH ACTION. Refer to paragraphs 131 through 139 for switch inspection and test.

(6) LUBRICATION. If motor and switch tests are satisfactory add 3 to 5 drops of engine oil (SAE 30) to oiler and install yoke linkage cover and head band.

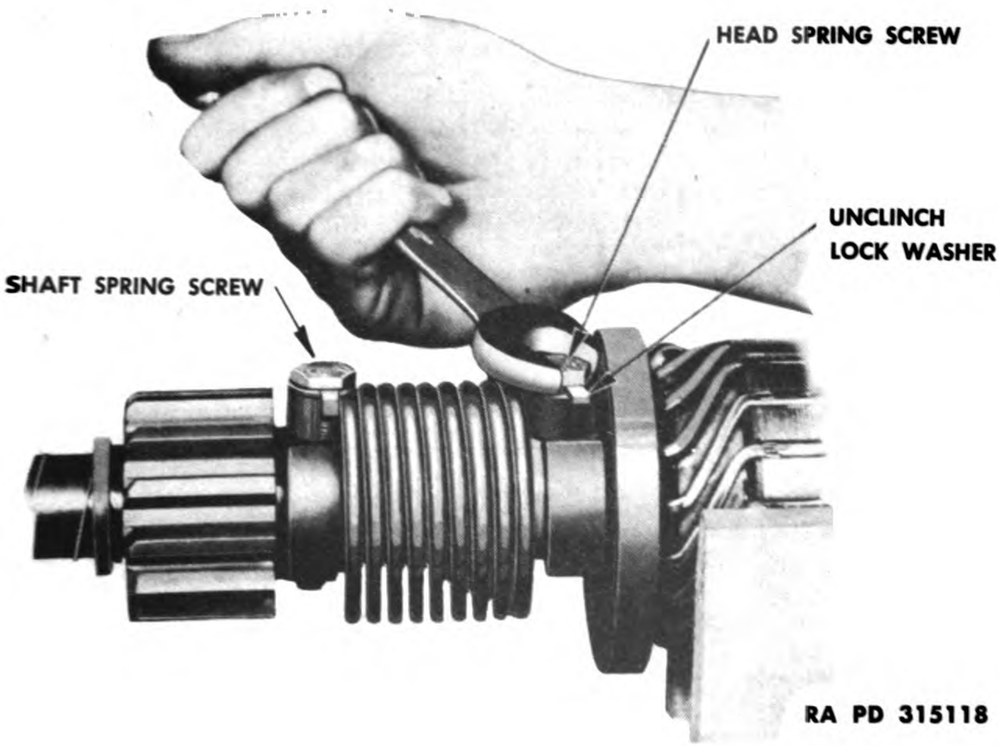


Figure 129—Removing Bendix Head Spring Screw

95. DISASSEMBLY.

a. Remove Switch (if pertinent).

(1) Remove yoke linkage cover and gasket. (Solenoid type only).

(2) Remove cotter pin and yoke link pin. (Solenoid type only).

(3) Remove switch to motor connector. (Solenoid type only).

(4) Remove switch mounting screws and lift off switch.

b. Remove Cover Band. Loosen clamp screw and slide band from motor.

c. Lift Brushes Out of Holders. Lift brush springs and remove brushes from holders (fig. 124).

d. **Remove Pinion Housing Screws** (if pertinent). Remove screws holding pinion housing to frame or gear housing.

e. **Remove Through Bolts** (if pertinent). Remove two through bolts at commutator end.

f. **Remove Pinion Housing or Drive End Head.**

(1) Pull pinion housing or drive end head from motor. On some types armature will remain in head or housing. On clutch types clutch and thrust washer may slide off shaft and leave armature in frame. Lift armature out of frame or press it out of pinion housing (fig. 128).

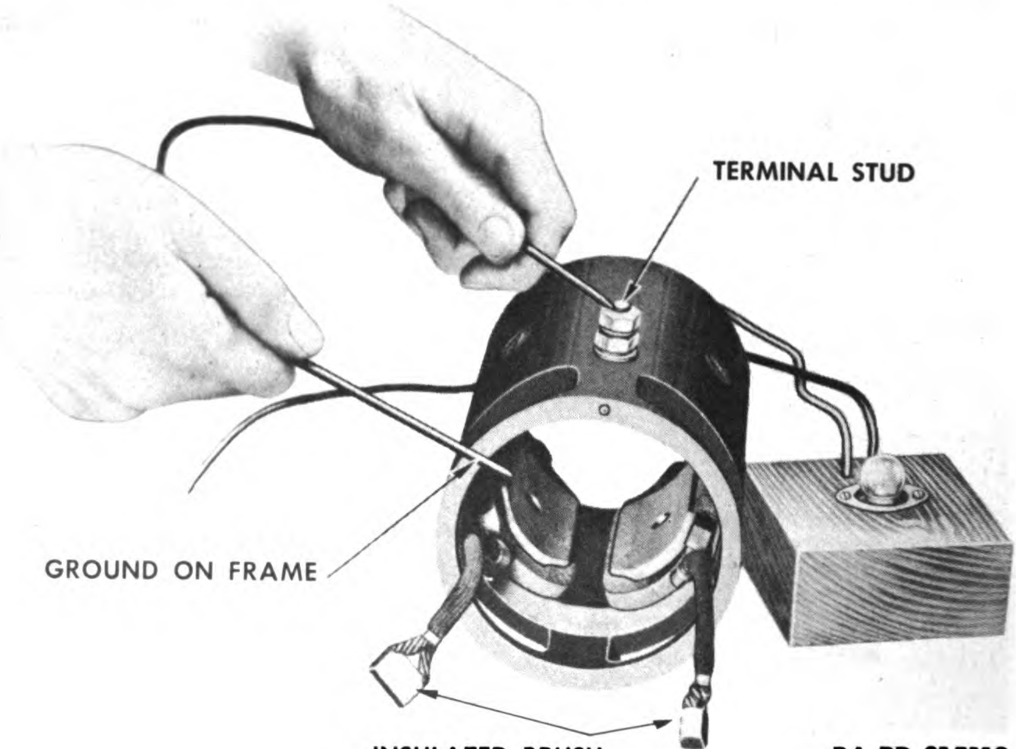


Figure 130—Testing Field Coils for Grounds with Test Probes—Group 1 Motors

(2) Disassemble yoke pivot screw, spring and retainer from pinion housing on clutch type motors.

g. **Remove Bendix Shaft and Intermediate Housing** (MAX 4041 only).

(1) Pull intermediate housing from motor and remove armature.

(2) Remove retainer screws and take off retainer and counter shaft.

h. **Remove Commutator End Head.**

(1) Take out commutator end head attaching screws (if pertinent).

(2) Tap head lightly with soft hammer and lift off motor.

i. Remove Bendix (if pertinent).

(1) Unclinch head spring screw lock washer and back off head spring screw (fig. 129). Slide Bendix from shaft. Remove Woodruff key and intermediate bearing plate.

(2) On MAY 4137 remove lock ring and pin from Bendix head and slide Bendix and drive end head from shaft. Note order as each piece is removed.

96. CLEANING OF COMPONENTS.

a. Frame and Field Assembly.

(1) Remove grounded brushes if screwed to frame.

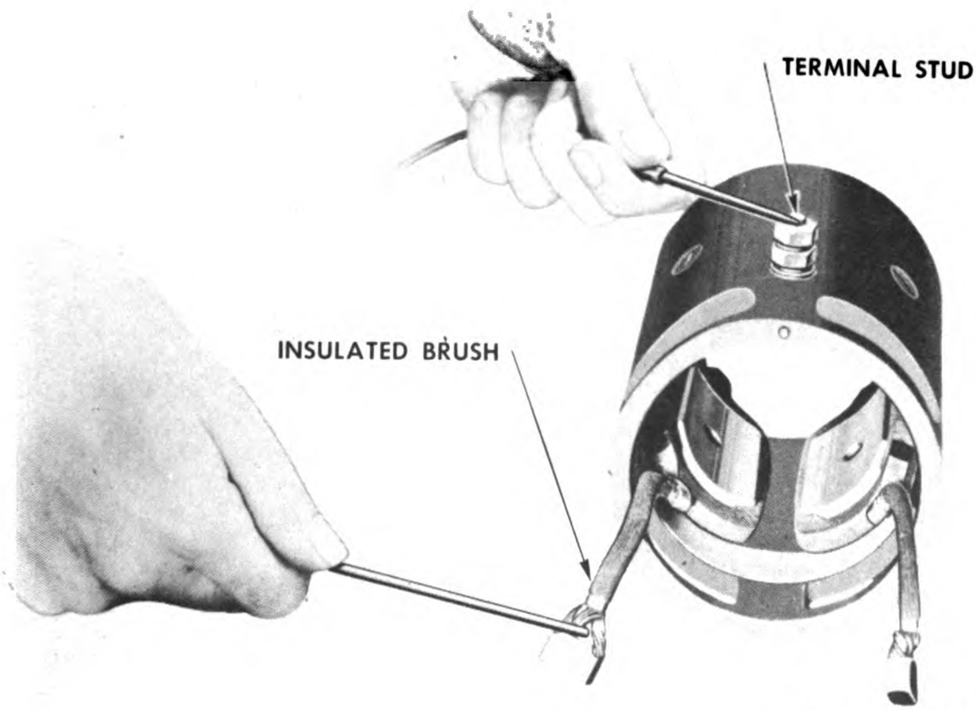


Figure 131—Testing Field Coils for Open Circuits with Test Probes—Group 1 Motors

(2) Thoroughly clean frame and field coils with cloth dampened in dry-cleaning solvent. Do not get solvent on brushes and do not soak. Be careful not to damage insulation and leads. Blow dry with compressed air. Wipe brushes with clean, dry rag.

b. Armature. Blow off all loose dirt with compressed air. Wipe armature with clean cloth dampened in non-oily cleaning solvent. Sand commutator with 2/0 flintpaper. Do not handle commutator.

c. Commutator End Head.

(1) Remove felt pad from bearing and wipe pad with clean cloth

(2) Dip head in dry-cleaning solvent and scrub with brush. Do not get solvent on brushes.

(3) Wipe brushes with clean dry rag.

d. **Drive End Head, Intermediate Housing or Pinion Housing.** Soak in dry-cleaning solvent and clean thoroughly.

e. **Overrunning Clutch.** Dip, do not soak in dry-cleaning solvent and clean with soft rag. Do not soak clutch mechanism as it is sealed and cannot be repacked with grease.

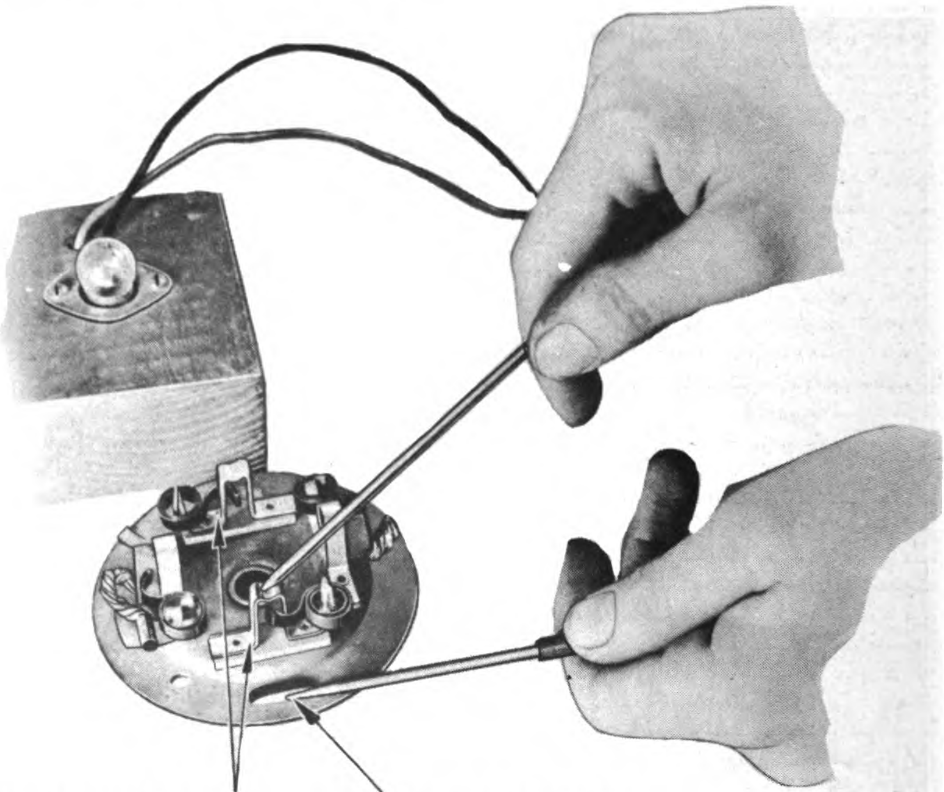


Figure 132—Testing Brush Holders for Grounds with Test Probes

f. **Bendix Drive.** Soak in dry-cleaning solvent and clean and dry thoroughly.

g. **Switch.** Wipe switch with cloth dampened in dry-cleaning solvent.

h. **Miscellaneous Parts.** Clean balance of parts in dry-cleaning solvent and dry thoroughly.

97. INSPECTION AND TEST OF COMPONENTS.

a. **Frame and Field.**

(1) Inspect frame and field for worn or frayed insulation, corroded or burned terminal stud, loose, corroded or burned terminals; and for

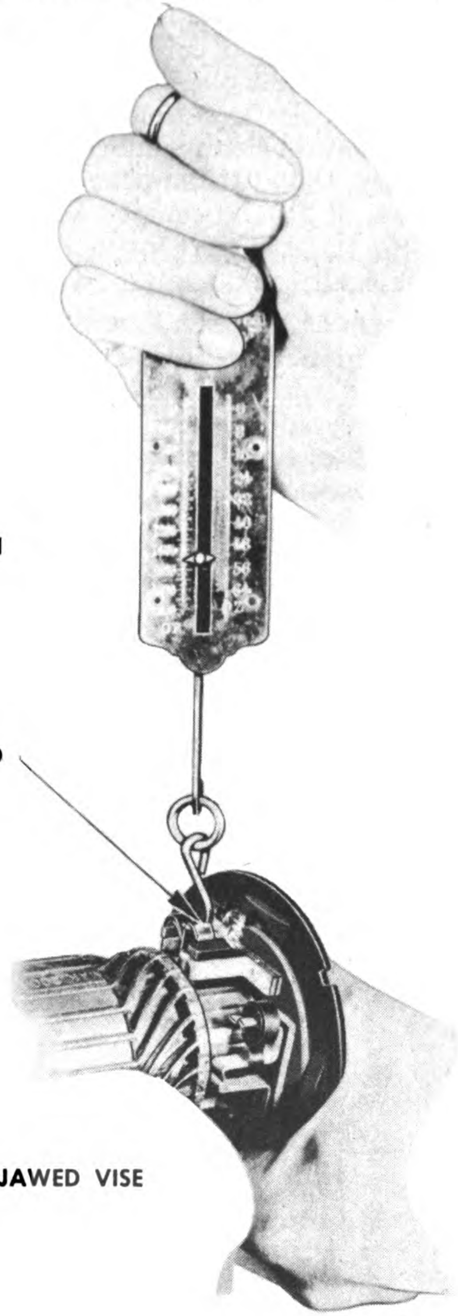


Figure 133—Measuring Brush Spring Tension with Tension Gage (41-G-105)

loose or corroded connections. All connections must be clinched and soldered. Repair or replace the parts affected if incorrect conditions are found (par. 98 a).

(2) Install new brushes (par. 98 a) if brushes are corroded, oil soaked, worn to less than 5/16 inch in length, or if leads are broken or frayed.

(3) Check field coils for grounds with test probes consisting of lamp in series with two points and source of electricity (fig. 12). Make sure brushes are not touching frame or pole shoes and touch one probe to terminal stud and other probe to an unpainted ground on frame (fig. 130). If lamp lights it indicates a ground is present. To find cause of ground remove field coils and terminal stud from frame (par. 98 **a**) and inspect for faulty terminal stud or field coil insulation. Replace faulty parts (par. 98 **a**).

(4) On MAW, MAX, and MZ-type motors unsolder and unclinch equalizer connection from one of the field coil leads. Touch one probe to terminal stud and touch second probe to each field coil connection and to insulated brushes (fig. 131). If an open is present the lamp will not light. Repair or replace the coil, lead or connection affected if an open is present (par. 98 **a**).

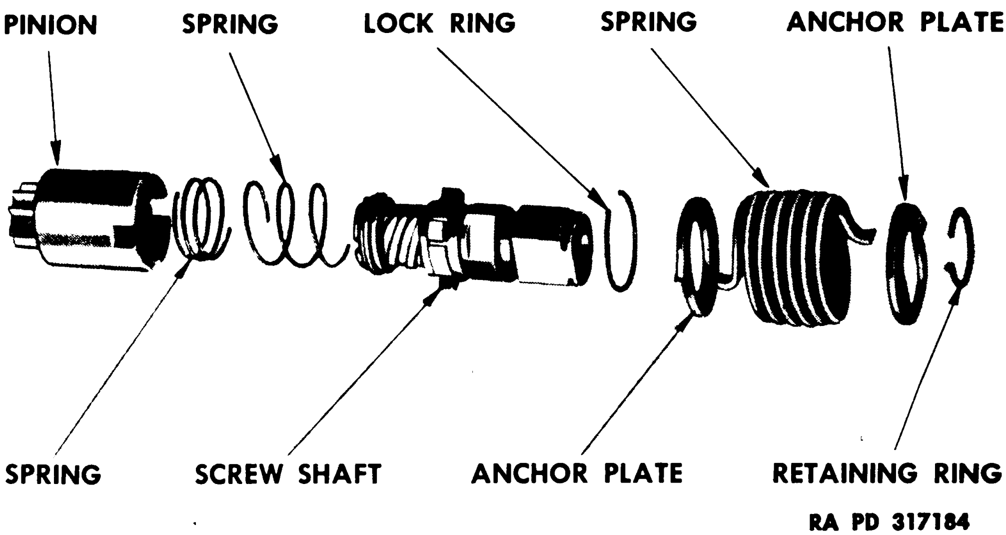


Figure 134—Bendix Drive for MAY 4137 Cranking Motor

b. Armature.

(1) Inspect to make sure all coils are pressed into core slots and all are staked and soldered to commutator risers. Solder if necessary (par. 98 **b**). Discard armature if core is badly scored. If commutator is rough or worn turn down (par. 98 **b**). Inspect shaft bearing seats for wear and replace armature if wear is evident.

(2) Touch one test probe to core or shaft and touch other probe to each commutator segment in turn (fig. 17). If ground is present lamp will light. Do not touch probes to bearing or brush surface as an arc would mar the finish. Replace armature if grounded.

(3) Place armature on growler and hold thin steel strip on core (fig. 18). Rotate armature slowly through a complete revolution. If a short is present steel strip will become magnetized and vibrate. Replace shorted armature.

(4) Place armature with shaft bearing seats on "V" blocks and mount dial indicator with plunger against commutator (fig. 19). Rotate armature slowly and read total runout. If commutator is more than 0.003 inches out of round turn down commutator (par. 98 **b**).

c. Commutator End Head.

(1) Inspect head for cracks and distortion. Discard if cracked or if not perfectly flat. Discard head if brush holders are bent or distorted. Install new brush springs if springs are corroded or distorted. Discard felt pad if torn or gritty.

(2) With test probes, check insulated brush holders for grounds (fig. 132). Discard head if either insulated brush holder is grounded.

(3) Install new grounded brushes (par. 98 **c**) if they are corroded, oil soaked, have broken or frayed leads or if they are worn to less than 5⁄16 inch in length.

(4) Place armature in padded vise and install thrust washer and commutator end head on shaft. Install grounded brush or spare brush in a brush holder. Replace head if brushes do not slide freely or if edge of brush is not in perfect alinement with commutator segments. Hook tension gage under brush spring and pull on a line parallel to face of the brush (fig. 133). Take reading just as spring leaves brush. With new brushes in place adjust tension to 42 to 53 ounces by twisting spring holder. With worn brushes the tension will be slightly less than above limits. When twisting spring holder do not distort spring or holder and be sure spring is clamped firmly. Install new brush spring (par. 98 **c**) if tension cannot be adjusted to 42 to 53 ounces with new brushes. Move brush to each holder and repeat above inspection and test.

(5) Feel side play of head when mounted on armature. Replace head if any side play can be felt as new bearing cannot be assembled without special tools.

(6) Remove brushes from holders and remove head and washer from armature.

d. Pinion Housing, Intermediate Bearings, or Drive End Head. Inspect and replace if cracked or distorted. Install armature shaft in bearing and hold housing so its weight will not twist and damage bearing. Feel side play of head or housing. If any side play can be felt install new bearing (par. 98 **d**).

e. Overrunning Clutch.

(1) Inspect for broken teeth on pinion and internal splines. Make sure the collar slides freely on shaft and spring compresses. Replace clutch if these conditions are not correct.

(2) Try fit of clutch splines on armature shaft splines. Replace clutch or armature if clutch does not slide easily.

(3) Hold clutch shaft and turn pinion to the right at pinion end. Clutch must release and pinion turn smoothly. Reverse direction of turning; clutch must instantly lock. Reverse direction again and clutch must instantly release. Replace clutch if it does not operate in this manner.

f. Bendix Drive. Inspect for broken springs, stripped screws, broken lock washers, and for broken pinion teeth. Replace any part not in good condition (par. 98 **f**). Turn pinion on shaft. Install new shaft and pinion if pinion does not turn freely with only the antidrift spring resisting movement (par. 98 **f**).

g. Switch.

(1) On manual switches inspect contacts and replace switch if contacts are pitted or rough. Clean contacts with 2/0 flintpaper. Replace switch if plunger action is sluggish and contacts do not make and break instantly.

(2) Refer to paragraphs 131 through 139 for solenoid switch inspection and test.

h. Miscellaneous Parts. Replace screws, washers, and other small parts, if not in good condition. Place cover band around motor and inspect to make sure it fits tightly against frame. Replace band if it cannot be straightened to make a tight fit.

98. REPAIR AND REBUILDING OF COMPONENTS.

a. Frame and Field.

(1) To install new field coils, connectors, terminal stud, or terminal post insulation, remove nut and washers from terminal post. Mark each pole shoe so that its position can be remembered and can be installed without interchanging or reversing. Take out pole shoe screws. Press terminal stud out of frame and pull coils and pole shoes out of frame. Lift insulating washer and bushing from terminal stud. Unsolder and unclinch connections to faulty part. Install new part and clinch tightly. Solder connection using rosin core solder. All connections must be strong mechanically and low resistance electrically. Place inner insulation on terminal stud and install field coils in frame. Place terminal stud in hole in frame. Install pole shoes in field coils in correct position marked before disassembly. Dip pole shoe screw in boiled linseed oil and install. Tighten pole shoe screws. Hit frame a few sharp blows with soft hammer as screws are tightened to aline and settle pole shoes. Install terminal post insulating bushing, insulating washer, plain washer, lock washer and nut; or insulation and switch contact on motors with manual switches.

(2) Replace brushes either with coils installed in frame or when coils are out of frame as described above (subpar. 98 **a** (1) above). Unsolder and unclinch brush lead from loop in field coil connector. Insert new brush lead to its full depth in loop and clinch tightly. Solder with rosin core solder. On MAW, MAX, and MZ-type motors be sure to clinch and solder equalizer connections at the same time brush is installed.

(3) If no repairs are needed on frame and field clinch and solder equalizer connection that was opened to make field coil open test (par. 97 **a**). Be sure brush lead is properly assembled at same time. On MAW, MAX, MAY, and MBY motors, assemble grounded brushes to frame and tighten attaching screw.

b. Armature.

(1) Do not attempt to repair armatures with worn or bent shafts,

badly scored core, shorted or open windings, or badly burned and scored commutator.

(2) Stake and solder loose armature coils to commutator risers. Use rosin core solder and be careful not to short across bars. Test armature for grounds and shorts (par. 97 **b**).

(3) If commutator is rough or worn or if runout is more than 0.003 inch place armature in lathe. Mount armature on bearing seats and not on shaft centers (fig. 22). Take light cuts until commutator is completely cleaned up. Remove all burs with 2/0 flintpaper (fig. 23). Do not undercut mica segments except on MBY 4001. On this motor undercut mica to depth of 1/32 to 3/64 inch (fig. 24). Be sure cut is clean and square and remove all burs (fig. 25). Check armature for shorts (par. 97 **b**) after turning commutator.

c. Commutator End Head.

(1) Do not attempt to repair heads if they are bent or bulged, have worn bearing or if insulated brush holders are grounded or bent.

(2) To install new grounded brushes or brush holders place head on table so that it is supported firmly and will not be bent. Drive out rivets holding grounded brush holder. Install new brush and holder on head and rivet in place. Be sure rivet is tight and swells to fill hole. It is important that rivet be tight to hold brush holder firm and to make a good ground contact.

d. Pinion Housing, Intermediate Bearings, or Drive End Head. Drive out worn bearing with bolt or arbor that rests on bearing and does not gouge bearing bore. Install new bearing on arbor of proper diameter to give correct bearing size (par. 101 **b**). Install bearing in plate, head or housing so that it is flush with bearing bore on end noted (par. 101 **b**).

e. Overrunning Clutch. There are no repairs of the overrunning clutch except complete replacement.

f. Bendix Drive. Remove spring screws and lock washers and disassemble Bendix drive. Replace faulty parts and assemble.

g. Starting Switch (pars. 130 to 139).

h. Miscellaneous Parts. Iron out any kinks in cover band and glue cork gasket to band. Install new switch contact if it is badly burned or pitted or clean with file and sandpaper. Be sure contact face is perfectly flat.

99. ASSEMBLY.

a. Lubrication. Soak bronze bearings and felts in engine oil (SAE 30) and remove excess oil. Apply film of engine oil (SAE 10) to armature shaft. Lubricate Bendix screw shaft sparingly with engine oil (SAE 10).

b. Intermediate Housing (MAX 4041 only).

(1) Install key and gear on countershaft. Place shaft in bearing and pack 1/4 ounce of high temperature grease on gear teeth. Install flat retainer, thick felt washer, cupped retainer and second felt washer on shaft. Fasten in place with three screws and lock washers.

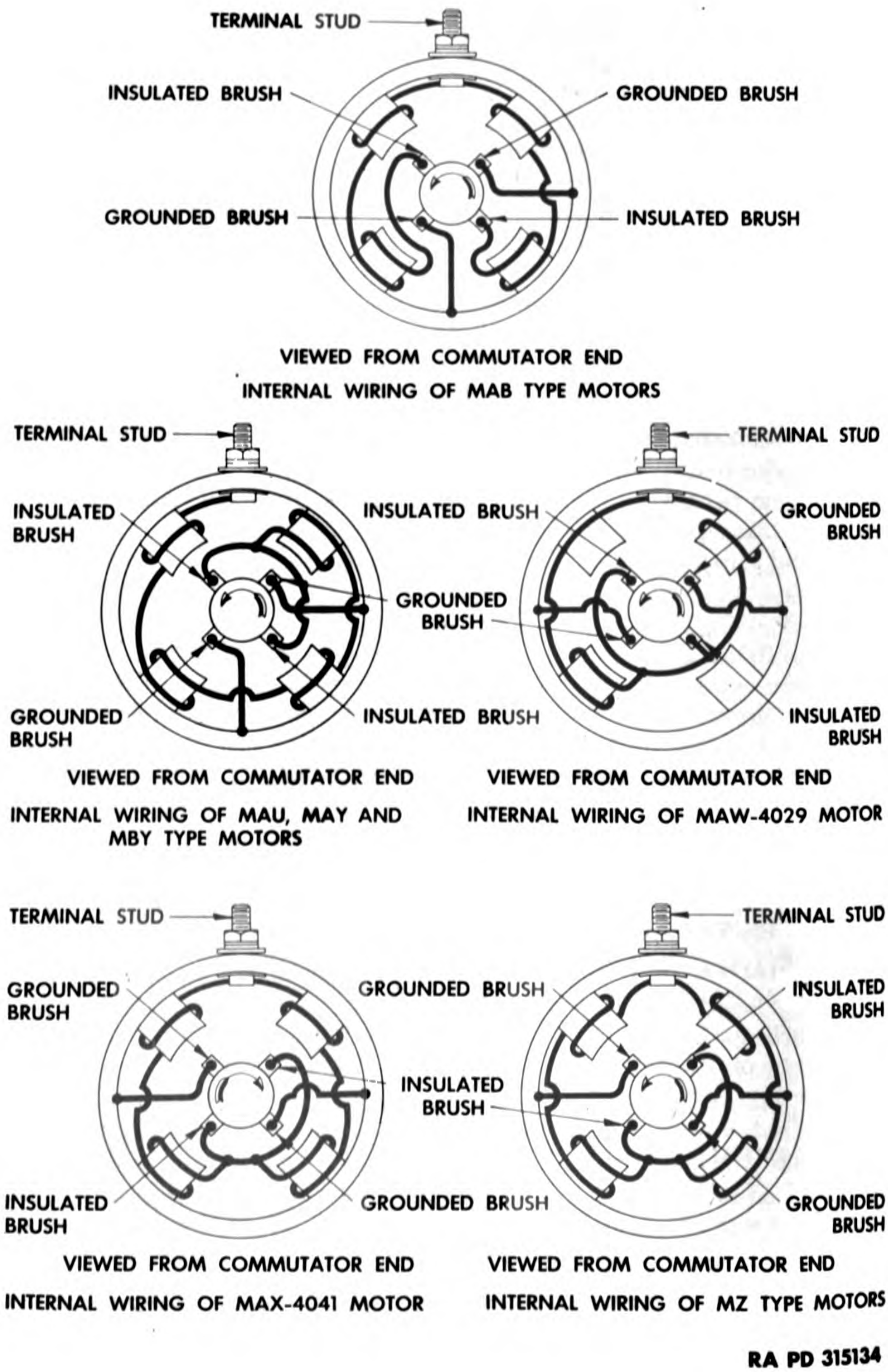


Figure 135—Internal Wiring Diagrams of Group 1 Motors

(2) Install return spring and spring pin on yoke arm. Install pivot pin and fasten in place with cotter pin.

(3) Place pinion housing on table with open end up. Put drive end thrust washer in place on the inside of bearing bore. Place yoke arm in its approximate position in housing. Install clutch on countershaft. Hold in place and assemble intermediate housing to pinion housing. Thread clutch shoes into yoke collar. Yoke shoes must be installed with curved side toward pinion end of clutch. Check to see that yoke shoes and return spring are properly installed and that outer thrust washer is in place. Install three screws and lock washers holding pinion housing to intermediate housing.

(4) Install long yoke pivot bushing and yoke pivot screw from right side when looking at motor end of housing with yoke arm up. Install short yoke bushing, lock washer, and nut.

(5) Tighten yoke pivot and housing screws.

c. Assemble Bendix to Armature.

(1) Place intermediate bearing plate on shaft with hub toward armature. Install Woodruff key. Place Bendix drive on shaft. Tighten spring screws making sure head spring screw enters hole in shaft. Clinch lock washer ears against side of screw heads.

(2) On MAY 4137 place drive end head on armature and install Bendix drive on shaft (fig. 134). Install pin in Bendix head and place lock ring over pin.

d. Assemble Armature to Pinion Housing.

(1) Place pinion housing on table with open end up and place yoke in position on housing.

(2) On clutch type assemble clutch to shaft and put drive end thrust washer in place on pinion housing bearing.

(3) Install armature in pinion housing. On Bendix type aline slot in intermediate bearing with dowel pin and press into place. On clutch type install yoke shoes in clutch collar. CAUTION: *Yoke shoes must be installed with curved side toward pinion end.*

(4) Put yoke pivot screw in place to hold yoke in position.

e. Install Frame and Field. Place frame and field over armature. On MZ-type motors install pinion housing attaching screws and lock washers.

f. Install Commutator End Head. Place thrust washers on commutator end of shaft and place felt pad in bearing. Install head on motor. Install through screws and lock washers, or on MZ-type motors, commutator end attaching screws and lock washers.

g. Tighten Screws.

(1) Make sure lock washers are in place on all screws.

(2) Partially tighten through bolts or head and housing screws.

(3) Strike motor frame one or two blows with soft hammer to aline bearings.

(4) Tighten through bolts, or head and housing attaching screws.

h. Assemble Yoke Pivot. Install yoke spring, retainers, bushings, lock washer and nut and tighten.

i. Install Brushes. Lift brush springs (fig. 124) and install brushes in holders. Be sure grounded brushes are in grounded brush holders.

j. Install Cover Band. Place band around motor and turn to cover all inspection holes. Tighten clamp screw.

k. Install Switch. Mount switch on motor and fasten with mounting screws and lock washers.

l. Assemble Solenoid Switch Linkage. Install pin in place connecting yoke to switch plunger. Install cotter pin after adjustments of pinion clearance (par. 100 **b**).

m. Install Switch Connector. Install connector on switch and motor terminals and install lock washers and nuts. Tighten securely.

100. TESTS AND ADJUSTMENTS.

a. Refer to paragraph 94 **c**.

101. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Poles—4

Brushes—4

Bearings—absorbent bronze.

Lubrication—Add three to five drops of engine oil (SAE 30) to oilers after assembly and every 100 hours of operation. Soak bearings, felt washers and pads in engine oil (SAE 30) and drain off excess oil before assembly. Apply a wipe of engine oil (SAE 10) to armature shaft, Bendix threads and to clutch splines before assembly. Pack gear reduction chamber with 1/4 ounce of high temperature grease at assembly and add 1/8 ounce to chamber every 300 hours of operation.

b. Mechanical.

Rotation—clockwise at drive end.

Brush length (new)—15/32 inch.

Brush length (worn)—5/16 inch minimum.

Commutator diameter (new)

MAB, MAU, MZ types—1.562 inches.

MAW, MAY, MAX, MBY types—1.750 inches.

Commutator diameter (worn)

MAB, MAU, MZ types—1.45 inch minimum.

MAW, MAY, MAX, MBY types—1.65 inch minimum.

Brush spring tension—42 to 53 ounces with new brushes.

End play

Bendix type motors—1/16 inch maximum.

Clutch type motors—0.005 inch to 0.030 inch.

Commutator runout (total reading)—0.003 inch maximum.

CRANKING MOTORS—GROUP 1

Commutator mica undercut

MAB, MAU, MAW, MAY, MAX, MZ—*Do not undercut.*
MBY type—1/32 inch to 3/64 inch.

Shaft diameter (new)

Commutator end—0.636 to 0.637 inch.

Intermediate—0.624 to 0.625 inch or 0.9985 to 0.999 inch.

Drive end—0.4985 to 0.499 inch or 0.624 to 0.625 inch.

Bearing diameter (new)

Commutator end—0.638 to 0.639 inch.

Intermediate—0.628 to 0.630 (MAX 4041 has two intermediate bearings—1.000 to 1.001 inch and 0.626 to 0.627 inch).

Drive end—0.500 to 0.501 inch or 0.626 to 0.627 inch.

Bearing assembly

Pinion housing bearing—flush at both ends.

Intermediate bearing—MAX 4041 armature shaft bearing flush on armature end, countershaft bearing flush on clutch end. All other intermediate bearings flush at both ends.

Drive end head bearing—MAY 4137 flush on outer end.

Pinion Clearance (overrunning clutch type motors)

At rest position

MAW 4029, MAY 4114A, MAY 4114B, MAY 4132, MAY 4133, MZ 4059, MZ 4059A, MZ 4089A, MZ 4115—1 3/16 to 1 23/64 inches from face of mounting flange to outer edge of pinion.

MAX 4041—25/32 inches to 61/64 inches from face of mounting flange to outer edge of pinion.

MAY 4141—7/16 inches to 39/64 inches from face of mounting flange to outer edge of pinion.

Full mesh position—(all)—1/16 inch to 3/32 inch between pinion and drive end thrust washer.

Manual switch plunger travel—overrunning clutch type motors—5/32 inch approximate.

Bendix drive stop clearance—1/16 inch maximum between stop and inside face of pinion housing bearing bore.

c. **Electrical.**

Rated volts—See tabulation (par. 101 **d**).

Starting switch—See tabulation (par. 101 **d**).

Clutch type—See tabulation (par. 101 **d**).

Internal wiring diagram—figure 135.

No load current draw—See tabulation (par. 101 **d**).

No load speed—See tabulation (par. 101 **d**).

Stall torque and current—See tabulation (par. 101 **d**).

Test wiring—figure 127.

d. Tabulated Specifications.

Unit	Rated Volts	Clutch Type	Switch Type	Volts	No Load Max Amps	Min RPM	Volts	Stall Torque Max Amps	Min Ft Lbs
MAB 4071	6	Bendix	....	5.5	60	3,700	3.0	582	15.8
MAB 4082	6	Bendix	....	5.5	60	3,700	3.0	582	15.8
MAU 4006	12	Bendix	....	11.0	65	4,800	6.0	540	17.3
MAW 4029	6	Overrunning	Man—On Motor	5.5	55	4,900	3.0	505	11.5
MAX 4041	6	Overrunning	Sol—On Motor	5.5	77	2,695	3.0	652	33.5
MAY 4114A	12	Overrunning	Man—On Motor	11.0	30	5,300	6.0	285	13.2
MAY 4114B	12	Overrunning	Man—On Motor	11.0	30	5,300	6.0	285	13.2
MAY 4132	12	Overrunning	Man—On Motor	11.0	30	5,300	6.0	285	13.2
MAY 4133	12	Overrunning	Sol—On Motor	11.0	30	5,300	6.0	285	13.2
MAY 4137	12	Bendix	....	11.0	30	5,300	6.0	285	13.2
MAY 4138	12	Bendix	....	11.0	30	5,300	6.0	285	13.2
MAY 4141	12	Overrunning	Sol—On Motor	11.0	30	5,300	6.0	285	13.2
MBY 4001	24	Bendix	....	20.0	20	4,200	12.0	180	15.0
MZ 4059	6	Overrunning	Man—On Motor	5.5	70	4,300	3.0	420	7.8
MZ 4059A	6	Overrunning	Man—On Motor	5.5	70	4,300	3.0	420	7.8
MZ 4089A	6	Overrunning	Man—On Motor	5.5	70	4,300	3.0	420	7.8
MZ 4113	6	Bendix	....	5.5	70	4,300	3.0	420	7.8
MZ 4115	6	Overrunning	Man—On Motor	5.5	70	4,300	3.0	420	7.8

CHAPTER 5

CRANKING MOTORS (Cont'd)

Section III

CRANKING MOTORS—GROUP 2

102. DESCRIPTION AND DATA.

a. Description (fig. 136). Group 2 cranking motors are four-pole, four-brush heavy-duty units. The brushes are mounted on arms pivoted on the commutator end head. The brush springs bear on the brush arms. Two of the brushes are grounded to the head by a jumper lead while the other two brushes are connected to a field coil lead. For model numbers of group 2 cranking motors, see paragraph 1.

b. Data.

Rotation—clockwise at the drive end.

Volts—MAS 4003, 4009, ML 4209—12.

ML 4211, MR 4104—6.

Brush spring tension—12 to 16 ounces with new brushes.

Type of clutch—Bendix.

End play—1/16 inch maximum.

Drive stop clearance—1/8 inch maximum.

Starting switch

MAS 4003, MAS 4009, MR 4104—Mounted separate.

ML 4209, ML 4211—Solenoid, mounted on motor.

No-load Current and Speed

MAS type—11.0 volts, 42 max amps, 4100 min revolutions per minute.

ML type—5.5 volts, 60 max amps, 2980 min revolutions per minute.

MR type—5.5 volts, 50 max amps, 2800 min revolutions per minute.

Stall Torque and Current

MAS type—6.0 volts, 440 max amps, 20.0 min ft lb

ML type—3.0 volts, 555 max amps, 18.0 min ft lb

MR type—3.0 volts, 525 max amps, 30.0 min ft lb

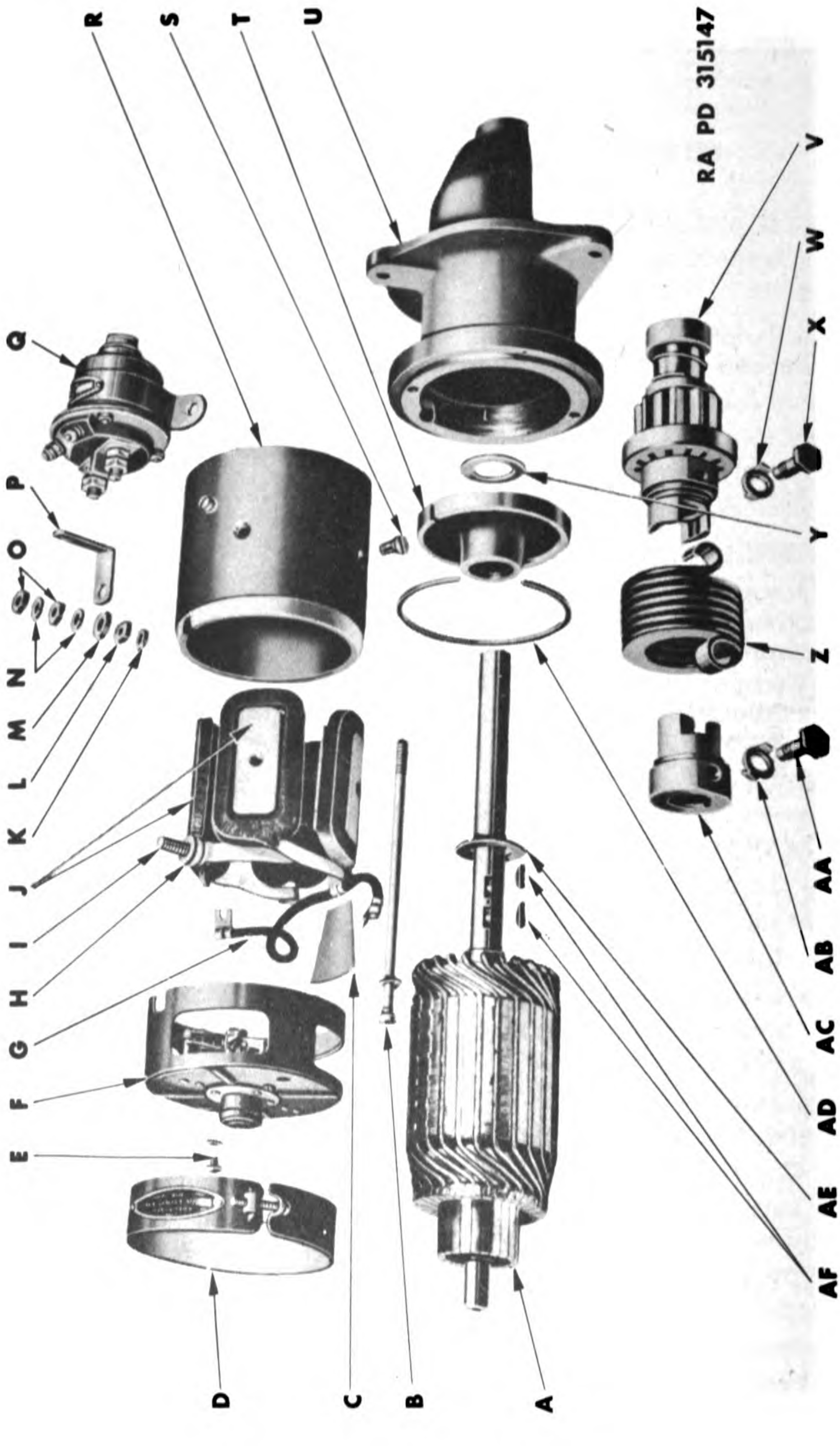


Figure 136—Main Components of Group 2 Motors

103. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Wipe outside of motor with cloth dampened in dry-cleaning solvent. Do not allow solvent to enter motor.

(2) Loosen cover band clamp screw and slide band from motor.

(3) Hold 2/0 flintpaper against commutator and turn armature slowly until commutator is clean. Blow sand and dust from commutator and brushes with clean, dry, compressed air.

b. Inspecting.

(1) Inspect frame, pinion housing and commutator end head for cracks. Disassemble and overhaul motor (pars. 104 to 109) if cracks are found. If commutator end head is not perfectly flat disassemble motor and install new head. Install new Bendix pinion if teeth are cracked, broken, or unevenly worn (pars. 104 to 109).

A—ARMATURE
B—THROUGH BOLT
C—INSULATOR
D—COVER BAND
E—BRUSH GROUND SCREW
F—COMMUTATOR END HEAD
G—BRUSH LEAD
H—INSULATING WASHER
I—TERMINAL STUD
J—FIELD COILS AND POLE SHOES
K—FRAME INSULATION
L—HEAD INSULATION
M—WASHER
N—LOCK WASHER
O—NUT
P—SWITCH TO MOTOR CONNECTOR
Q—SWITCH
R—FRAME
S—POLE SHOE SCREW
T—INTERMEDIATE BEARING ASSEMBLY
U—PINION HOUSING
V—BENDIX PINION AND SHAFT ASSEMBLY
W—LOCK WASHER
X—SHAFT SPRING SCREW
Y—THRUST WASHER
Z—BENDIX DRIVE SPRING
AA—HEAD SPRING SCREW
AB—LOCK WASHER
AC—BENDIX HEAD
AD—LOCK RING
AE—THRUST WASHER
AF—WOODRUFF KEY

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Legend for Figure 136—Main Components of Group 2 Motors

(2) Inspect brushes and brush arms. Lift brush arms and blow off brushes and arms with clean, dry, compressed air. If brush arms are dirty, corroded, or gummy, or if they do not swing easily overhaul motor (pars. 104 to 109). If brushes are oil soaked or are worn to less than ⅜ inches in length replace. To remove brushes hold brush arm up and loosen brush screw (fig. 137). Slide worn brush off screw and install new brush. Make sure lead terminal and lock washer are outside brush. Hold brush straight and tighten screw. Release brush arm and inspect brush alinement. Loosen brush screw and straighten brush so that edge of brush is in perfect alinement with commutator segments. If brush alinement cannot be adjusted overhaul motor (pars. 104 to 109) and install new brush arms.

(3) Inspect commutator. If commutator is an even brown color without burns or grooves it needs no attention. Overhaul motor (pars. 104 to 109) if commutator is rough, worn or burned.

(4) Hold armature and turn Bendix pinion. It must move out along shaft without restrictions other than antidrift spring. When pinion reaches the stop it must lock to armature shaft. If Bendix does not act in this manner or if any doubt exists as to condition of Bendix drive, disassemble motor and inspect further (pars. 104 to 109).

(5) Inspect switch to see that it is mounted firmly and that connections are clean and tight.

c. **Testing.**

(1) MEASURE END PLAY. Mount dial indicator on motor with

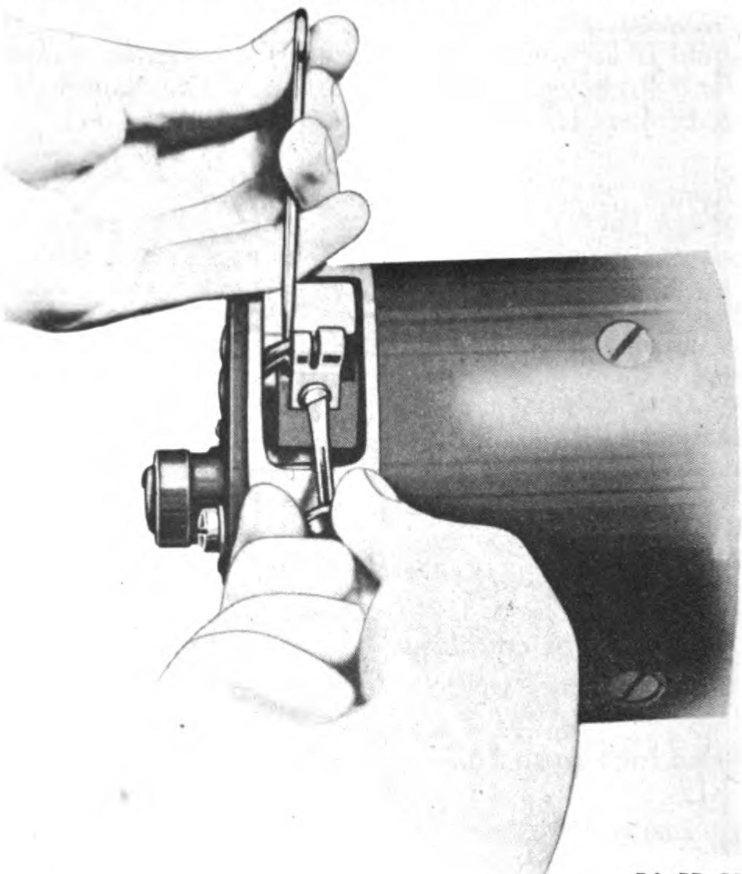

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Figure 137—Disconnecting Brush Lead and Removing Brushes on Group 2 Motors

plunger against end of shaft (fig. 125). Move armature to its two extreme positions and note total indicator reading. If end play is more than 1/16 inch overhaul motor and look for improper assembly (pars. 104 to 110). Install thrust washers on commutator end of armature shaft to bring end play within limits.

(2) MEASURE BENDIX CLEARANCE. Measure clearance between Bendix drive stop and outer pinion housing bearing bore (fig. 126). If this clearance is more than 1/8 inch maximum inspect commutator end head and Bendix spring for distortion and replace if distorted (pars.

104 to 109). If head and spring are in good condition disassemble motor and install thrust washers on armature shaft just inside commutator end head (pars. 104 and 108).

(3) MEASURE NO-LOAD DRAW AND SPEED (fig. 127).

(a) Connect 100-ampere ammeter, carbon pile rheostat, and battery of rated voltage (par. 102 **b**) in series with motor terminal stud and frame. Connect voltmeter from motor terminal to frame. Close test stand battery switch, adjust voltage to specified value (par. 102 **b**) and read ammeter. Hold tachometer against drive end of armature shaft while operating at specified voltage. If current is higher than specified value or if speed is low, overhaul motor (pars. 104 to 109)

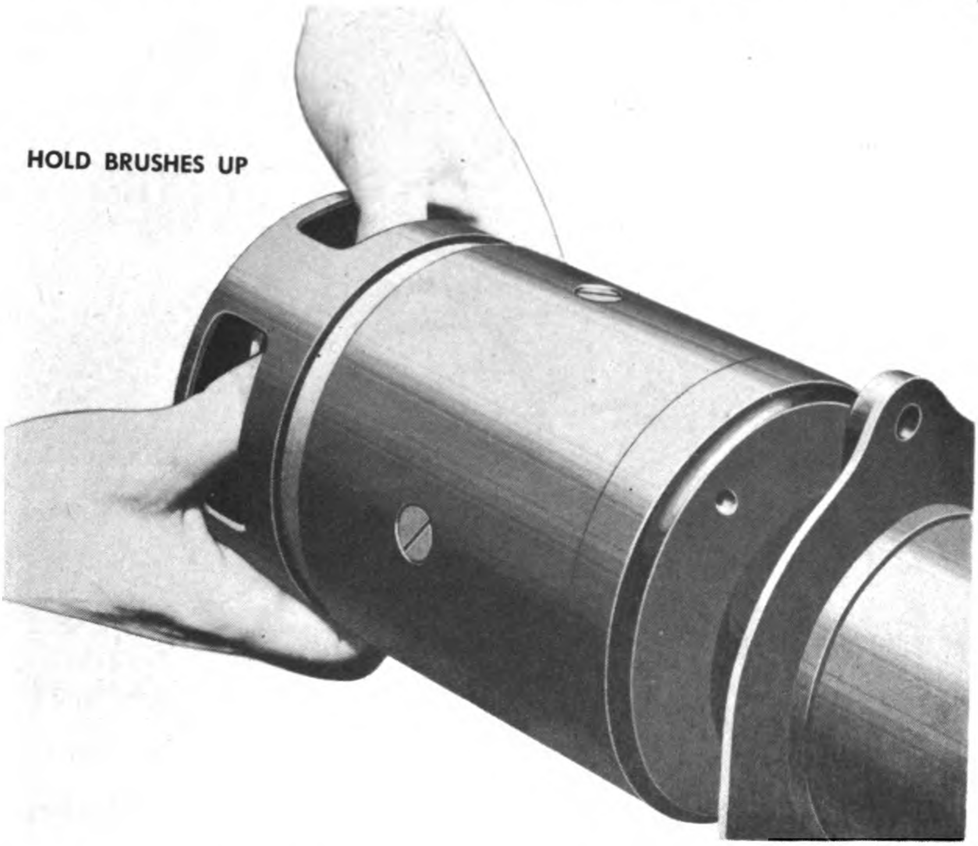


Figure 138—Removing Commutator End Head—Group 2 Motors

and look for evidences of binding on armature and for shorts within motor. If current and speed are both low overhaul motor (pars. 104 to 109) and look for high resistance connections at terminal stud, field coils, and brushes.

(b) Inspect Bendix pinion while operating at no load. If pinion does not shift when motor is started and stopped overhaul motor and inspect Bendix (pars. 104 to 109).

(4) MEASURE STALL CURRENT AND TORQUE. Change ammeter to 1,000 ampere scale and connect as for no load test (par. 103 **c** (3)

above). Clamp motor down and mount torque arm and spring scale on motor. Close test stand battery switch. Adjust voltage to figure specified (par. 102 **b**) and read ammeter and spring scale. Open test stand battery switch. Multiply spring scale reading by length, in feet, of torque arm to get torque. If current is higher than specifications (par. 102 **b**) and torque low it indicates shorts or improper assembly of motor. If current and torque are both low it indicates high resistance in internal connections at field coils, armature or brushes. Overhaul motor (pars. 104 to 109) and look for these conditions if stall torque and current are incorrect.

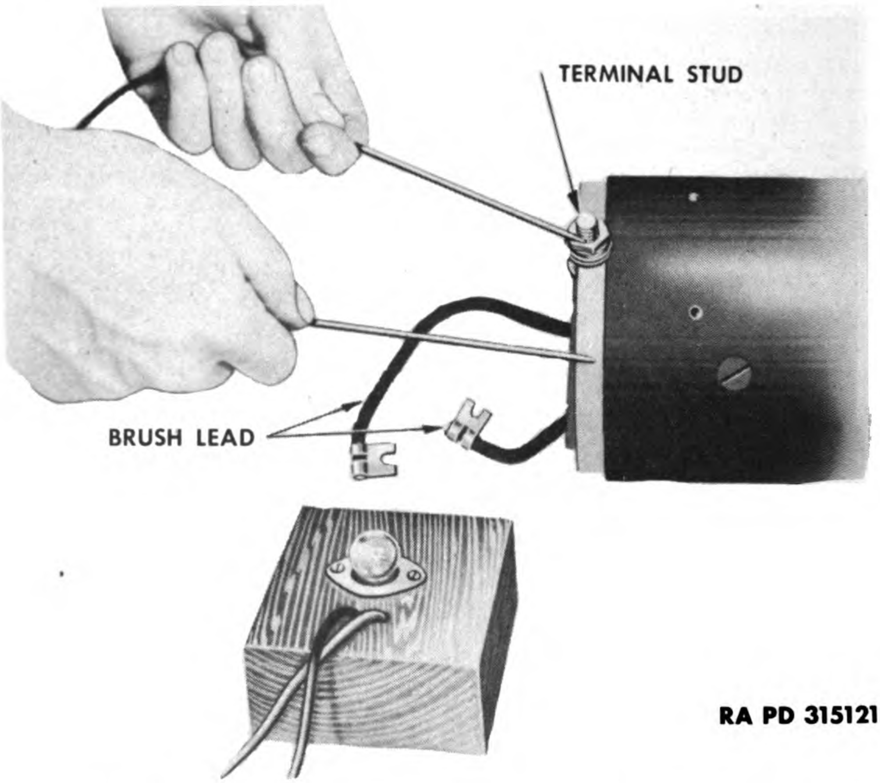


Figure 139—Testing Field Coils for Grounds with Test Probes—Group 2 Motors

(5) CHECK SOLENOID SWITCH ACTION. Refer to paragraphs 131 through 139 for switch inspection and test.

(6) LUBRICATION. If the motor and switch tests are satisfactory add three to five drops of medium engine oil to oiler and install cover band on motor.

104. DISASSEMBLY.

a. Remove Switch (if pertinent). Remove terminal stud nuts and lift off connector. Take out mounting screws, and lift switch from motor.

b. Remove Cover Band. Loosen clamp screw and slide band from motor.

c. Disconnect Brush Leads. Loosen insulated brush screws and pull leads from screws (fig. 137).

d. Remove Commutator End Head. On MAS and ML type remove two frame screws at commutator end. On MR type take off two hex nuts at commutator end. Hold brushes off commutator to prevent cracking and pull head from motor (fig. 138).

e. Remove Frame and Field. On MR type take out eight pinion housing attaching screws. Pull frame and field from armature and pinion housing.

f. Remove Pinion Housing.

(1) On MR 4104 remove plug on side of pinion housing. Unclinch lock washer, loosen Bendix head spring screw, and pull armature from housing. The Bendix will remain in housing and can be lifted out. Remove Woodruff key and washer from shaft.

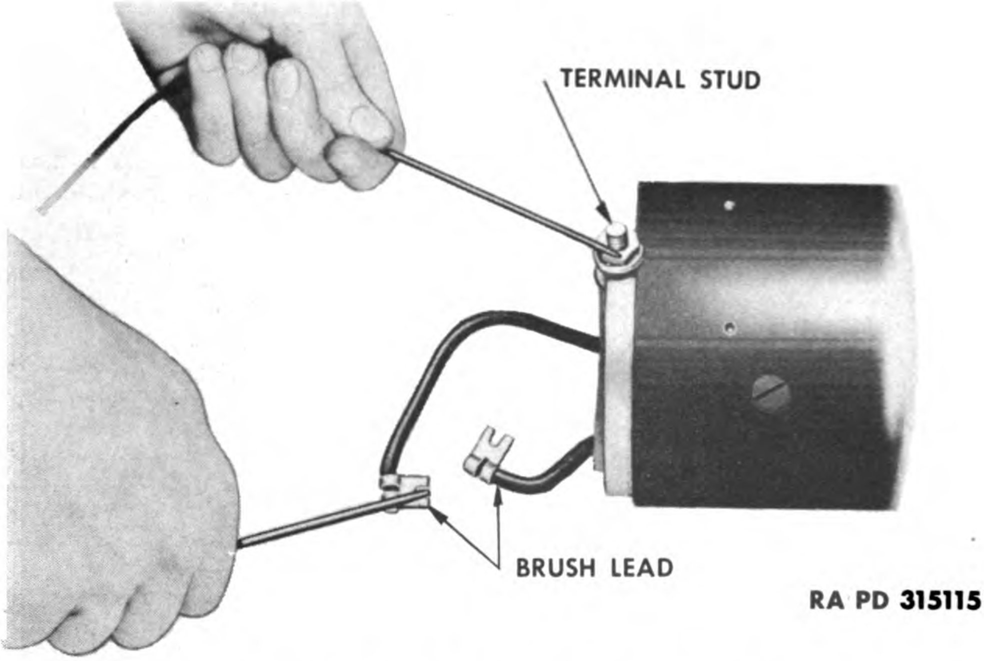


Figure 140—Testing Field Coils for Open Circuits with Test Probes—MAS-type Motors

(2) On ML 4209 remove intermediate bearing lock ring and pull armature from pinion housing.

(3) On MAS 4003, MAS 4009, and ML 4211 press on drive end of armature shaft (fig. 128).

g. Remove Bendix. Unclinch lock washer and loosen Bendix head spring screw (fig. 129). Pull Bendix from shaft. Remove key, intermediate bearing, and washer, from shaft.

105. CLEANING OF COMPONENTS.

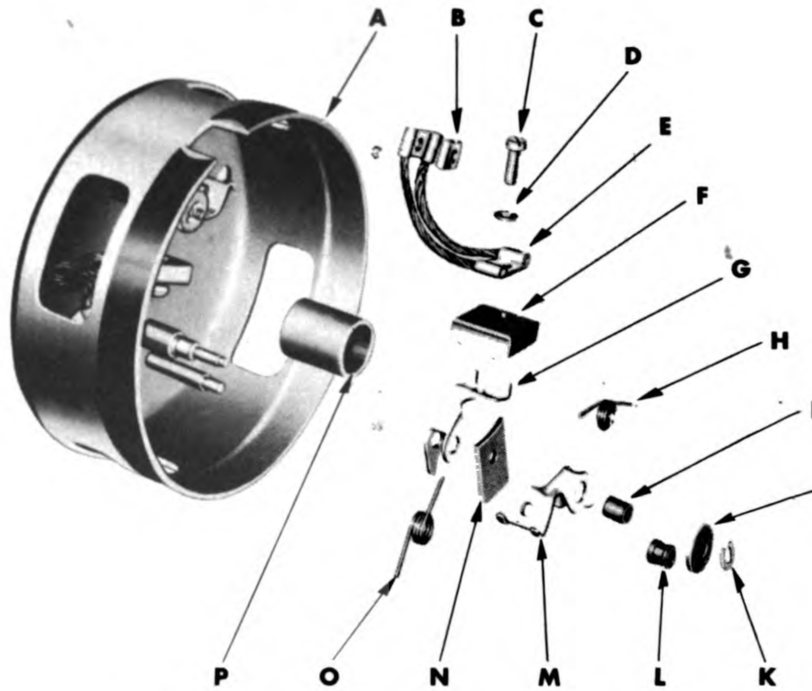
a. Frame and Field Assembly. Thoroughly clean frame and field

coils with cloth dampened in dry-cleaning solvent. Do not soak. Be careful not to damage insulation and leads. Dry with compressed air.

b. Armature. Blow off all loose dirt with compressed air. Wipe armature with clean cloth dampened in non-oily dry-cleaning solvent. Polish commutator with 2/0 flintpaper. Do not handle commutator.

c. Commutator End Head.

(1) Loosen brush screws and remove brushes from head. Remove dust cover from outer end of bearing.



A—HEAD ASSEMBLY, PARTIAL
B—GROUND SCREW NUT
C—BRUSH SCREW
D—BRUSH SCREW LOCK WASHER
E—GROUND LEAD
F—GROUNDED BRUSH
G—GROUNDED BRUSH HOLDER
H—INSULATED BRUSH SPRING
I—BRUSH ARM INSULATING BUSHING
J—INSULATING WASHER
K—BRUSH HOLDER POST CLIP
L—SPRING INSULATOR
M—INSULATED BRUSH HOLDER
N—SPACING INSULATION
O—GROUNDED BRUSH SPRING
P—BEARING

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Figure 141—Parts of Commutator End Head—Group 2 Motors

(2) Dip head and cover in dry-cleaning solvent and scrub with brush. Do not damage or bend brush holders, springs or insulation.

(3) Wipe brushes with clean cloth slightly dampened in dry-cleaning solvent.

d. Pinion Housing, Intermediate Bearing, and Bendix Drive. Soak in dry-cleaning solvent and clean and dry thoroughly.

e. Switch. Wipe switch with cloth dampened in dry-cleaning solvent.

f. Miscellaneous Parts. Clean balance of parts in dry-cleaning solvent and dry thoroughly.

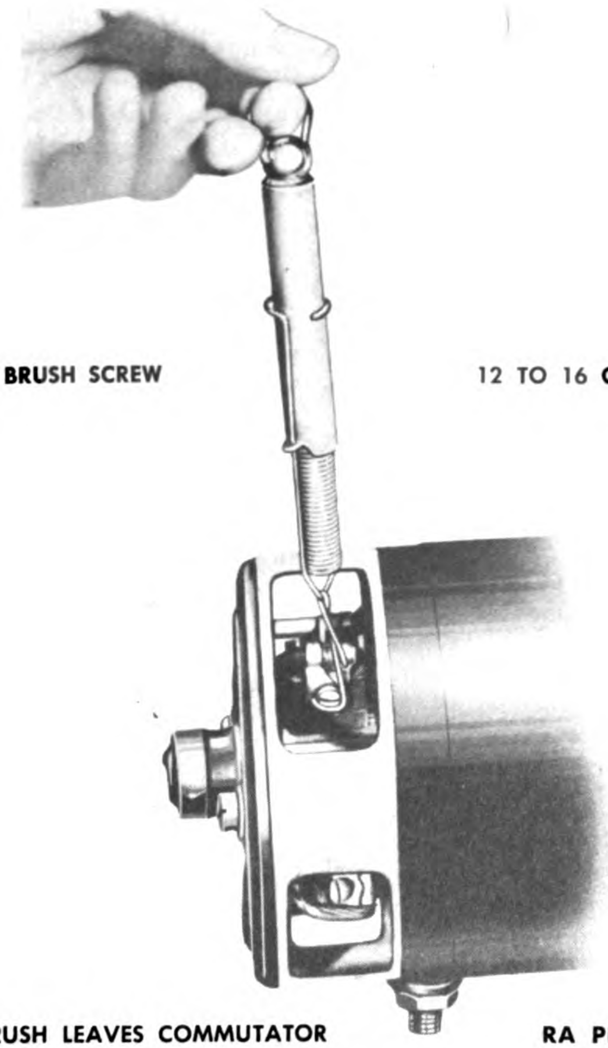


Figure 142—Measuring Brush Spring Tension on Group 2 Motors with Tension Gage (41-G-105)

106. INSPECTION AND TEST OF COMPONENTS.

a. Frame and Field.

(1) Inspect frame and field for worn, cracked or frayed insulation, corroded or burned terminals, and for loose or corroded connections. All connections must be clinched and soldered. Repair or replace faulty parts (par. 107 a).

(2) Make sure brush lead terminals are not touching frame or pole pieces and touch one test probe to the terminal stud and other probe to unpainted ground on frame (fig. 139). If lamp lights it indicates a ground is present. To find cause of ground remove field coils and terminal stud from frame (par. 107 **a**) and inspect for faulty terminal stud and field coil insulation. Reassemble frame and field using new parts where necessary (par. 107 **a**).

(3) Inspect visually and by touch all connections, leads and windings in field coil assembly to make sure they are clinched and soldered and no breaks or partial breaks are present. If in doubt as to connections clinch and solder using rosin core solder. On MAS-type motors check for open circuits by touching test probes to terminal post and field coil lead terminal (fig. 140). If an open circuit is present, repair or replace faulty part (par. 107 **a**).

b. Armature.

(1) Inspect to make sure all coils are pressed into core slots and all are staked and soldered to commutator risers. Solder if necessary (par. 107 **b**). Discard armature if core is badly scored or if windings are loose. Turn down commutator (par. 107 **b**) if rough or worn. Replace armature if wear is evident on shaft bearing seats.

(2) Touch one test probe to core or shaft and touch other probe to each commutator segment in turn (fig. 17). Do not touch probes to bearing or brush surface. Replace armature if grounded as indicated by lamp lighting.

(3) Place armature on growler and hold thin steel strip on core (fig. 18). Rotate armature slowly. Replace armature if shorted as indicated by steel strip becoming magnetized.

(4) Place armature with bearing seats on "V" blocks and mount dial indicator with plunger against and perpendicular to commutator (fig. 19). Rotate armature slowly and read total indicator reading. Turn commutator down (par. 107 **b**) if total runout is more than 0.003 inches.

c. Commutator End Head (fig. 141).

(1) Inspect head for cracks and distortion. Replace head if cracked, bent or if face is not perfectly flat. Install new brush holders, insulation or brush springs if these parts are cracked or distorted (par. 107 **c**). Install new brushes if brushes are oil soaked or are worn to less than 3/8 inch in length (par. 107 **c**). Install new ground leads if leads are frayed or improperly clinched and soldered to terminals.

(2) Turn brush arms on their pivots. If arms do not pivot easily inspect arms and pivots for corrosion and wear. Replace head if pivots are not in good condition and replace arms if pivot holes are worn (par. 107 **c**).

(3) Install brushes on holders with short side toward holder, and connect ground leads to grounded brushes. Arrange leads so they do not interfere with brush movement.

(4) Place armature in padded vise and install thrust washer on commutator end of shaft. Hold brushes up and install commutator end head on armature. Inspect brush alinement on commutator. If

brush is not in perfect alinement with commutator segments loosen brush screw and settle brush more firmly in place, then tighten brush screw. Install new brush arms (par. 107 **c**) if this does not correct brush alinement or if brushes are not centered on commutator. Hook tension gage under brush screw tight against brush. Pull on line parallel to face of brush (fig. 142). Take reading just as brush leaves commutator. Disassemble head and bend brush spring to obtain brush spring tension of 12 to16 ounces.

(5) Feel side play of head when mounted on armature. Install new bearing if any side play can be felt (par. 107 **c**).

(6) Hold brushes off commutator and remove head and washer from armature.

d. Pinion Housing and Intermediate Bearing. Discard housing or bearing plate if cracked or distorted. Install intermediate bearing in housing and install armature shaft in bearings. Feel side play at both ends of housing. Replace bearing affected if side play can be felt (par. 107 **d**).

e. Bendix Drive. Inspect for broken springs, stripped threads, broken lock washers and for broken pinion teeth. Discard any part not in good condition. Turn pinion on shaft. If pinion does not turn smoothly with only the antidrift spring resisting movement, discard shaft and pinion. Disassemble drive and install new parts where necessary (par. 107 **e**).

f. Starting Switch (pars. 131 to 139).

g. Miscellaneous Parts. Replace screws, washers and other small parts if not in good condition. Place cover band around motor and inspect to make sure it fits tightly around frame. Discard band if it cannot be straightened to make a tight fit.

107. REPAIR AND REBUILDING OF COMPONENTS.

a. Frame and Field.

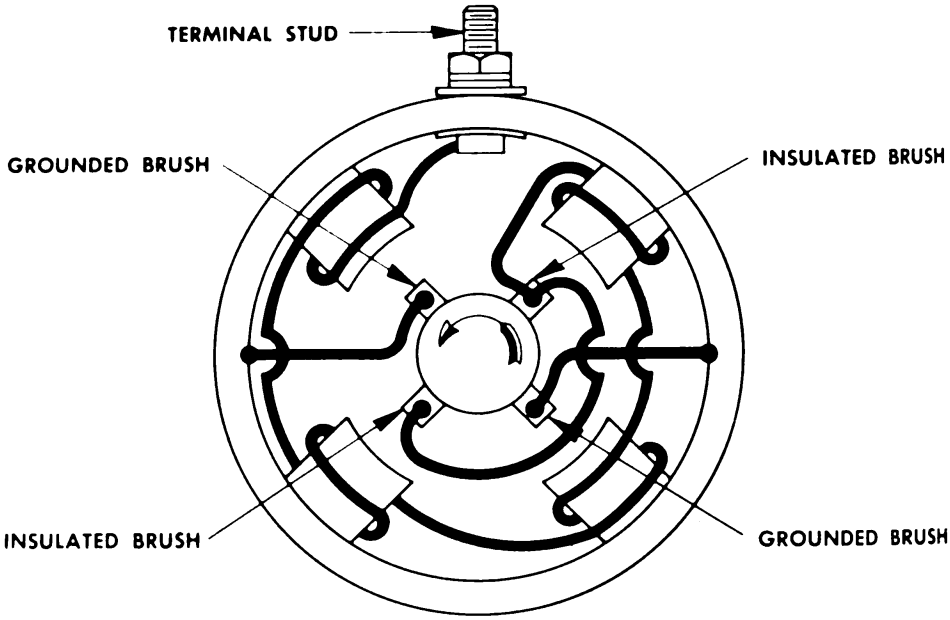
(1) Mark each pole shoe so that they can be installed in correct position without interchanging or reversing. Remove pole shoe screws and terminal stud nut and washers. Take out pole shoes and slide field coils and terminal stud out of frame.

(2) Unsolder and unclinch connections to faulty part. Install new part and clinch and solder with rosin core solder. All connections must be strong mechanically and low resistance electrically.

(3) Install inner insulation on terminal stud and place coils in frame. Install pole shoes in proper position (subpar. 107 **a** (1) above). Dip pole shoe screws in boiled linseed oil and install in frame. As screws are tightened hit frame one or two sharp blows with soft hammer to aline pole shoes. Install frame insulation, head insulation, insulating washer, plain washer, lock washer and nut on terminal stud.

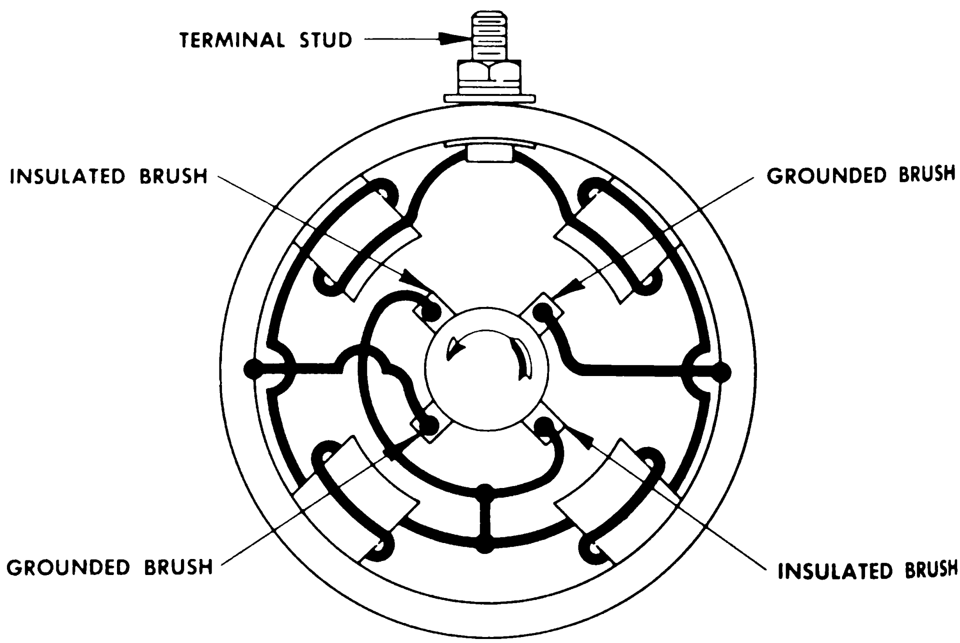
b. Armature.

(1) Do not attempt to repair armatures with worn or bent shafts, badly scored core, shorted or loose windings or badly burned and scored commutator.



VIEWED FROM COMMUTATOR END

INTERNAL WIRING OF MAS-4003 AND MAS-4009 MOTORS



VIEWED FROM COMMUTATOR END RA PD 315133

INTERNAL WIRING OF ML-4209, ML-4211 AND MR-4104 MOTORS

Figure 143—Internal Wiring Diagrams of Group 2 Motors

(2) Stake loose windings to commutator risers and solder with rosin core solder. Check armature for grounds and shorts (par. 106 **b**) after soldering.

(3) If commutator is rough, worn or out-of-round place in lathe. Mount on bearing seats and not on shaft centers (fig. 22). Take light cuts until commutator is completely cleaned up. Remove all burs with 2/0 flintpaper (fig. 23). Do not undercut mica segments. Check armature for shorts and grounds (par. 106 **b**).

c. Commutator End Head (fig. 141).

(1) Remove brushes and ground leads. Remove clips from brush holder studs. Take off insulation, arms, and springs. Drive worn bearing out of head with arbor that rests on bearing but does not damage bearing sleeve.

(2) Install new bearing on 0.5310-inch diameter arbor and press into bearing sleeve so that bearing is flush with sleeve on inner end. Be sure sleeve is down against the end of hub.

(3) Install brush arms, brush springs and insulation on head. Install brushes and ground leads.

(4) Check brush alinement and brush spring tension (par. 106 **c**).

d. Pinion Housing and Intermediate Bearing. Drive out worn bearing with bolt or arbor that rests on bearing but does not damage bearing bore. Install new bearing on arbor of proper diameter to give correct bearing size (par. 110 **b**). Press bearing into bearing bore and remove arbor.

e. Bendix Drive. Discard lock washers and defective parts. Assemble drive but do not tighten screws or clinch lock washers.

f. Starting Switch (pars. 131 to 139).

g. Miscellaneous Parts. Iron out kinks in cover band. Discard defective parts.

108. ASSEMBLY.

a. Lubrication. Soak bearings in engine oil (SAE 30) and remove excess oil. Apply film of engine oil (SAE 10) to armature shaft. Lubricate Bendix screw shaft sparingly with engine oil (SAE 10).

b. Install Bendix Drive (MR 4104 only).

(1) Tighten Bendix shaft spring screw and clinch lock washer against side of screw head.

(2) Assemble thrust washer, Woodruff key and lead slug on armature shaft.

(3) Install Bendix drive in housing. Insert armature shaft and turn so key is lined up with keyway in Bendix head. Press shaft into Bendix and tighten Bendix head spring screw so that it enters hole in shaft and compresses lead slug.

(4) Bend lock washer against side of head spring screw and install plug in pinion housing.

c. Install Bendix Drive (MAS 4003, 4009, ML 4209, ML 4211).

(1) Install thrust washer and intermediate bearing on shaft. On

ML 4209 install second thrust washer on shaft. Install Woodruff key or keys.

(2) Install Bendix drive on shaft and turn so key enters slot in Bendix head. Press Bendix into position.

(3) Tighten Bendix spring screws and clinch lock washers against sides of screw heads.

(4) Place pinion housing on armature and turn intermediate bearing so dowel pin enters slot in plate. Press intermediate bearing into housing.

(5) On ML 4209 motor install snap ring to hold intermediate bearing in place.

d. Install Frame and Field.

(1) Place frame and field on armature and turn so that dowel pin enters hole.

(2) On MR 4104 turn pinion housing so that flywheel hole is directly opposite terminal post. Install but do not tighten eight pinion housing attaching screws.

e. Install Commutator End Head.

(1) Hold brushes up and place head on motor. Be sure terminal post insulation is undamaged and correctly placed.

(2) On MAS and ML type install through screws and lock washers. As screws are tightened strike frame one or two sharp blows with soft hammer.

(3) On MR 4104 install commutator end attaching nuts and lock washers. Tighten nuts and pinion housing screws. As nuts and screws are tightened strike frame one or two sharp blows with a soft hammer to aline bearings.

f. Connect Brush Lead. Loosen insulated brush attaching screws and insert field coil lead terminal between brush and lock washer. Tighten screws and check brush alinement (par. 106 c (4)).

g. Install Switch. Tighten motor terminal stud nut. Mount switch and connector on motor and install mounting screws and terminal stud nuts.

109. TESTS AND ADJUSTMENTS.

a. Refer to paragraph 103 c.

110. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Poles—4.

Brushes—4.

Bearings—3 absorbent bronze.

Lubrication—Add three to five drops of engine oil (SAE 30) to oilers after each 100 hours of operation. Soak bearings in engine oil (SAE 30) before assembly. Apply light film of engine oil (SAE 10) to armature shaft and lubricate Bendix threads sparingly with engine oil (SAE 10).

b. Mechanical.

Rotation—Clockwise at drive end.

Brush Length (new)—25/32 inch.

Brush Length (worn)—3/8 inch minimum.
Commutator diameter (new)—1.683 to 1.693 inches.
Commutator diameter (worn)—1.50 inches minimum.
Brush spring tension—12 to 16 ounces with new brushes.
End Play—1/16 inch maximum.
Commutator runout (total reading)—0.003 inch maximum.
Shaft diameter (new)
  Commutator end—0.529 to 0.5295 inch.
  Intermediate—0.8705 to 0.8715 inch.
Drive end
  MAS 4003, MAS 4009 and ML 4211—0.6245 to 0.625 inch.
  ML 4209—0.746 to 0.7465 inch.
  MR 4104—0.6235 to 0.624 inch.
Bearing diameter (new)
  Commutator end—0.5305 to 0.5315 inch.
  Intermediate—0.8745 to 0.8765 inch.
  Drive end
    MAS 4003, MAS 4009, ML 4211—0.626 to 0.627 inch.
    ML 4209—0.7475 to 0.7485 inch.
    MR 4104—0.6245 to 0.626 inch.
Bendix drive stop clearance (1/8 inch maximum).

c. **Electrical.**

Rated volts—(see tabulation) (par. 110 **d**).
Starting switch
  MAS 4003, 4009 and MR 4104 (mounted separate).
  ML 4209 and ML 4211 solenoid (mounted on motor).
Type of clutch (Bendix).
Internal wiring diagram (figure 143).
Test wiring diagram (figure 127).
No-load current draw and speed (see tabulation) (par. 110 **d**).
Stall torque and current (see tabulation) (par. 110 **d**).

d. **Tabulated Specifications.**

Unit	Rated Volts	Volts	No Load Max Amps	Min RPM	Volts	Stall Torque Max Amps	Min Ft Lbs
MAS 4003	12	11.0	42	4,100	6.0	440	20.0
MAS 4009	12	11.0	42	4,100	6.0	440	20.0
ML 4209	12	5.5	60	2,980	3.0	555	18.0
ML 4211	6	5.5	60	2,980	3.0	555	18.0
MR 4104	6	5.5	50	2,800	3.0	525	30.0

CHAPTER 5

CRANKING MOTORS (Cont'd)

Section IV

CRANKING MOTORS—GROUP 3

111. DESCRIPTION AND DATA.

a. Description (figs. 144 and 145). Group 3 cranking motors are 24-volt special heavy-duty units. They are equipped with solid shaft clutch type Bendix drives specially designed to withstand large starting torques. These motors have four poles and eight brushes. The brushes are mounted in pairs with each pair connected in parallel. MBD 4007, A, B, and MBD 4010, A have a nine to 32 gear reduction between the armature shaft and Bendix shaft to increase the cranking torque. For model numbers of group 3 cranking motors, see paragraph 1.

b. Data.

Rated voltage—24.
Rotation—Clockwise at the drive end.
Brush spring tension—40 to 50 ounces with new brushes.
Poles—4.
Brushes—8.
End play—0.005 to 0.030 inches.
No load draw and speed

	MBD 4007, A, B MBD 4010, A	MBD 4008
Volts	20.0	20.0
Amps	70 maximum	65 maximum
RPM	1,480 minimum	5,300 minimum

Stall torque and current

	MBD 4007, A, B MBD 4010, A	MBD 4008
Volts	4.0	4.0
Amps	400 maximum	380 maximum
Ft Lbs	74 minimum	21 minimum

112. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Remove heat shield and terminal shield.

(2) Wipe outside of motor with cloth dampened in dry-cleaning solvent. Do not allow dry-cleaning solvent to enter motor.

(3) Loosen cover band clamp screw and slide band from motor.

(4) Hold 2/0 flintpaper against commutator and turn armature slowly until commutator is clean. Blow sand and dust from commutator and brushes with clean dry compressed air.

b. Inspecting.

(1) Inspect frame, pinion housing, commutator end head, and intermediate housing for cracks. Inspect Bendix pinion for cracks and uneven wear. Overhaul motor if cracks or uneven wear are found (pars. 113 to 119).

(2) Lift brush springs and remove brushes from holders (fig. 146). Blow off brushes and holders with clean dry compressed air. Overhaul motor if brush holders are dirty, gummy, or corroded, or if brushes are oil soaked or worn to less than 5/16 inches in length (pars. 113 to 119). Hold brush spring up with hook and try the fit of brushes in holders. Overhaul motor if brushes do not slide freely. Install brushes in holders and inspect brush alinement on commutator. Overhaul motor if edges of brushes are not in perfect alinement with commutator segments.

(3) If commutator is an even brown color without burns or grooves it needs no attention. Overhaul motor if commutator is rough, worn, or burned (pars. 113 to 119).

(4) Hold armature and turn Bendix pinion. It must move out along shaft without restrictions. When pinion reaches stop it must lock to shaft. Further turning must turn armature. If Bendix does not act as described above or if any doubt exists as to condition of Bendix drive, overhaul motor and inspect further (pars. 113 to 119).

c. Testing.

(1) MEASURE ARMATURE END PLAY. Remove bearing cover and felt pad from commutator end head. Stand motor on commutator end to settle armature. Lay motor flat and mount indicator (41-I-400) on motor with plunger against end of armature shaft (fig. 147). Set indicator then reach through inspection holes and move armature toward drive end. Read indicator. Disassemble motor and install thrust washers on commutator end of armature shaft if end play is more than 0.030 inch (pars. 113 to 119). If end play is less than 0.005 inch, overhaul motor and inspect for improper thrust washer and intermediate bearing assembly (pars. 113 to 119).

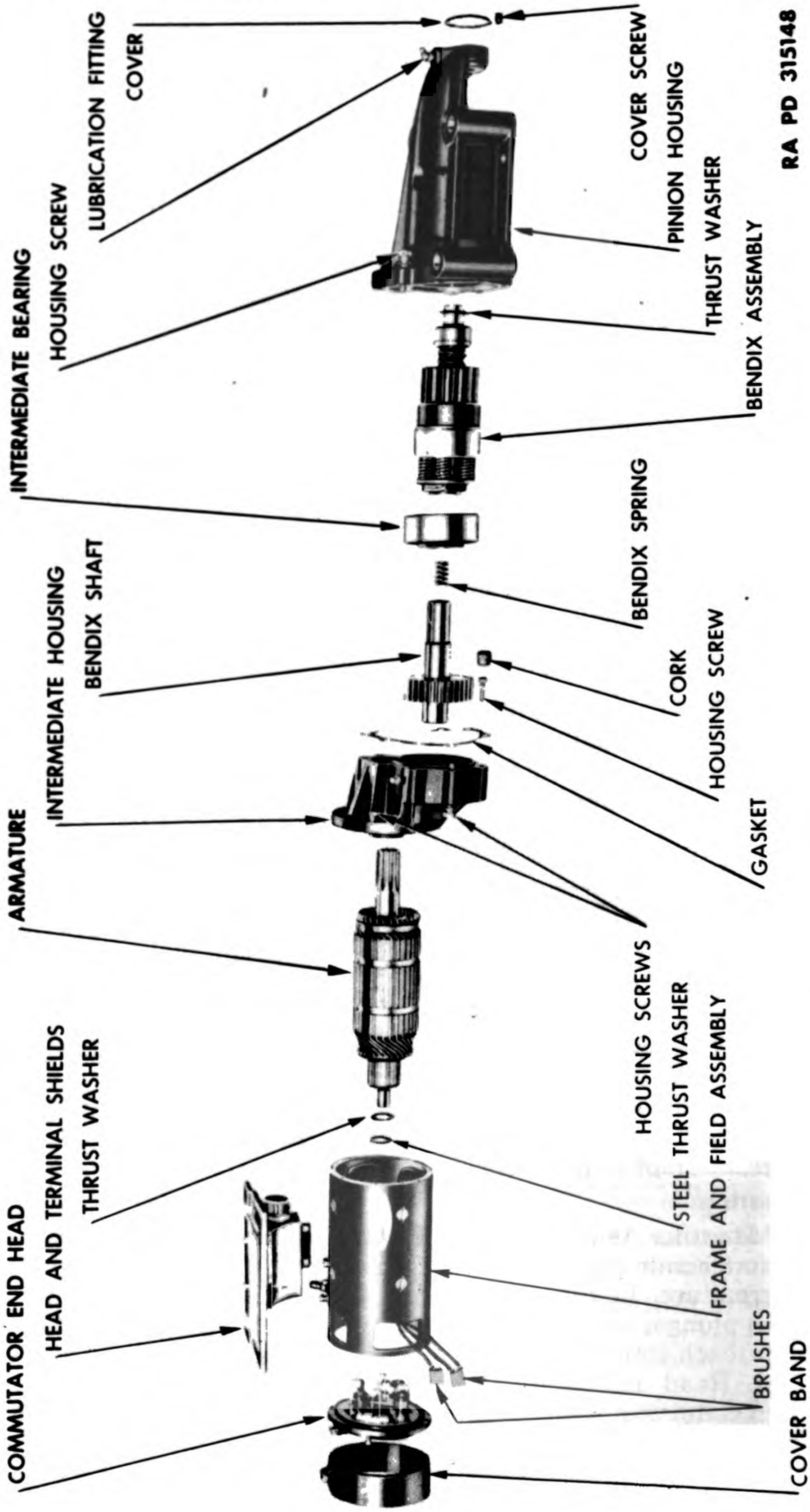


Figure 144—Components of MBD 4007, A, B and MBD 4010, A Cranking Motors, Partially Disassembled

(2) MEASURE NO-LOAD DRAW AND SPEED (fig. 127).

(a) Connect a 100 ampere ammeter, carbon pile rheostat, and 24-volt battery in series with motor terminal and frame. Connect voltmeter from motor terminal to frame. Close test stand battery switch and adjust carbon pile to give voltmeter reading of 20.0 volts. Read ammeter and hold tachometer against drive end of shaft while operating at 20.0 volts. If current is higher than specified value or if speed is low (par. 111 **b**) overhaul motor (pars. 113 to 119) and look for evidences of binding on armature or Bendix shaft and for shorts within motor. If current and speed are both low overhaul motor (pars. 113 to 119) and look for high resistance connections at terminal stud, field coils, or brushes.

(b) Inspect pinion while operating at no-load. If pinion does not shift when motor is started and stopped, overhaul motor and inspect Bendix (pars. 113 to 119).

(3) MEASURE STALL CURRENT AND TORQUE. With motor connected as for no-load test (par. 112 **c** (2) above) change ammeter to 1,000 ampere scale. Clamp motor down and mount torque arm and spring scale on motor. Close test stand battery switch and adjust rheostat to give voltage of 4.0 volts. Read ammeter and spring scale. Multiply spring scale reading by length of torque arm in feet to get stall torque. If current is higher and torque lower than specifications (par. 111 **b**) overhaul motor and look for shorts or improper assembly of motor.

(4) LUBRICATE MOTOR. If inspection and test show no need for overhaul, install cover band on motor and turn so all inspection holes are covered. Tighten and lock wire clamp screw. Install felt pad and cover on commutator end bearing. Add three to five drops of engine oil (SAE 30) to hinged top oilers. On MBD 4007, A, B and MBD 4010, A remove plug from gear housing and add ½ ounce of high temperature grease. Lubricate outer pinion housing bearing with pressure gun if equipped with fitting. Do not over-lubricate. Install heat and terminal shield.

113. DISASSEMBLY.

a. Remove Head Band. Loosen clamp screw and slide band from motor.

b. Remove Heat and Terminal Shields (if pertinent). Remove lock wires and take out attaching screws. Lift shields from motor.

c. Lift Brushes Out of Holders. Lift brush springs and pull brushes from holders (fig. 146).

d. Remove Pinion Housing.

(1) Remove lock wire from pinion housing attaching screws. Take out screws.

(2) Pull housing from motor. The shaft and Bendix will remain in the pinion housing. On MBD 4008 remove washers from commutator end of armature shaft.

(3) Press shaft out of pinion housing (fig. 128).

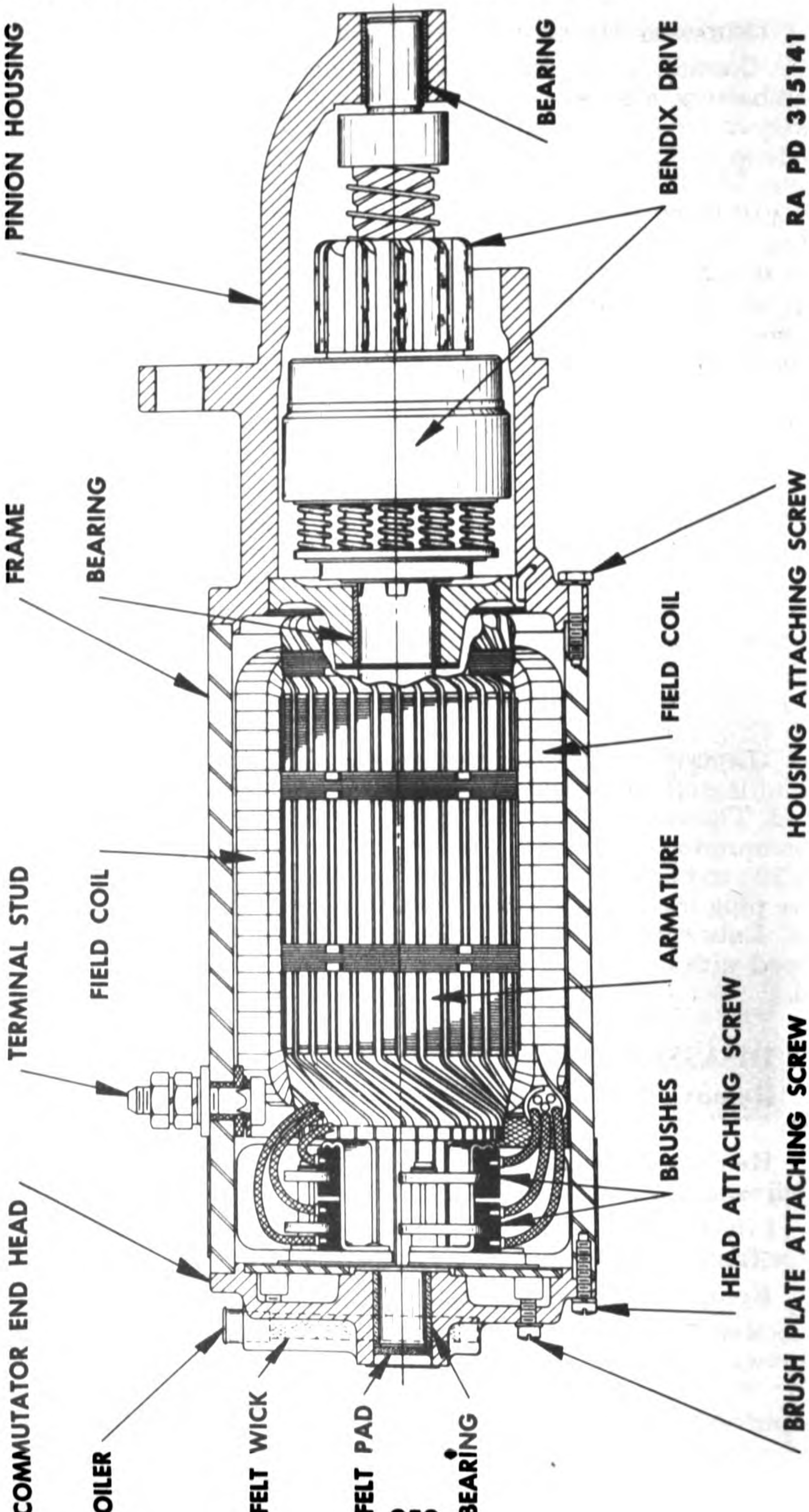


Figure 145—Sectional Drawing of MBD 4008 Cranking Motor

e. Remove Gear Housing (if pertinent) (fig. 148).

(1) Remove grease from chamber and pull two cork plugs from screw holes. Remove lock wires and take out seven housing attaching screws.

(2) Tap gear housing with soft hammer and remove from motor.

(3) Pull armature from motor and remove thrust washers from shaft.

f. Remove Commutator End Head. With straightedge and sharp point mark relationship of head to frame. Remove lock wires and take out attaching screws. Tap head lightly with soft hammer and remove from motor.

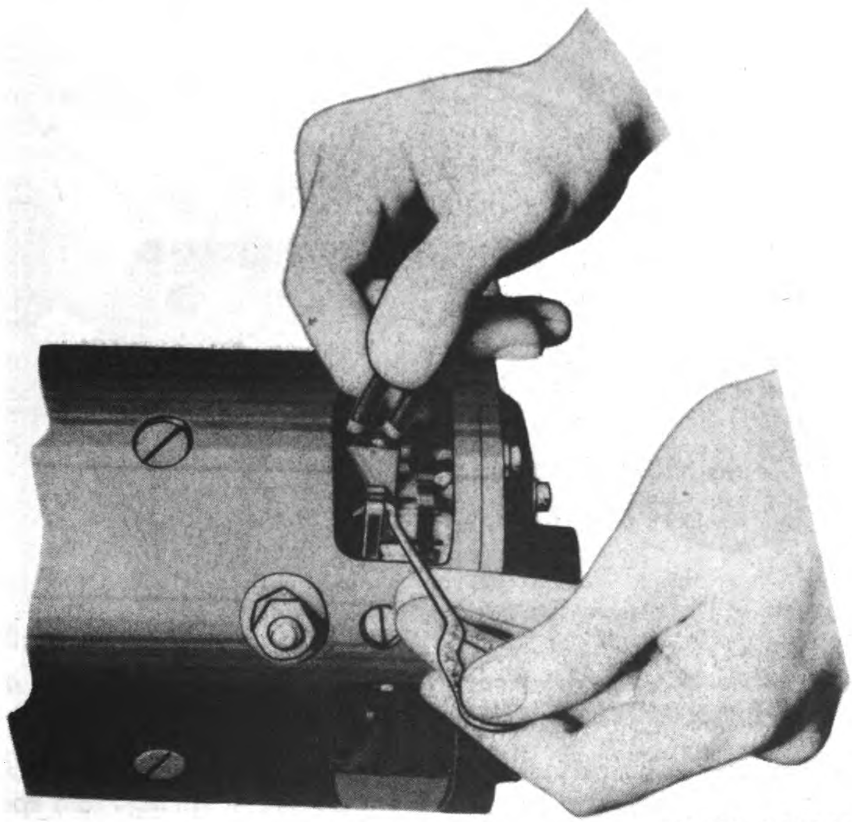


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Figure 146—Removing Brushes from Holders on Group 3 Motors

g. Remove Bendix Drive (fig. 149).

(1) Slip lock ring out of slot on Bendix lock screw. Do not clip wire lock ring. Remove lock screw.

(2) Pull Bendix from shaft and take out shaft spring if loose.

(3) Remove Woodruff keys (if pertinent).

(4) Slide intermediate bearing from shaft and remove thrust washers.

114. CLEANING OF COMPONENTS.

a. Frame and Field Assembly.

(1) Thoroughly clean frame and field coils with cloth dampened in dry-cleaning solvent. Do not get dry-cleaning solvent on brushes and do not soak. Be careful not to damage insulation and leads. Blow dry with compressed air.

(2) Wipe brushes with clean rag slightly dampened in dry-cleaning solvent. Do not soak.

b. Armature. Blow off all loose dirt with compressed air. Wipe armature with clean cloth dampened in dry-cleaning solvent. Sand commutator with 2/0 flintpaper. Do not handle commutator.

c. Commutator End Head.

(1) Remove cover and felt pad from bearing. Remove lock wire

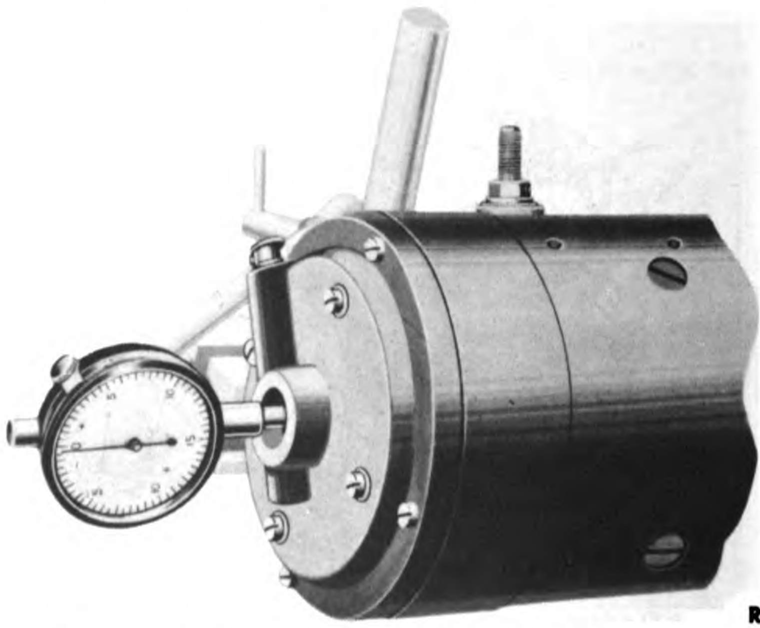

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Figure 147—Measuring Armature End Play on MBD 4007, A, B and MBD 4010, A Motors with Indicator (41-I-100)

and take out brush plate attaching screws. Lift off brush holder plate. Remove clips from brush spring posts. Remove brush springs and spacers.

(2) Wipe felt pad clean with rag. Dip brush holder plate in dry-cleaning solvent and clean and dry thoroughly. Soak head, springs, screws and cover, in dry-cleaning solvent and clean thoroughly.

d. Pinion Housing, Intermediate Bearing, and Intermediate Housing.

(1) Remove oil seal from intermediate bearing (if pertinent).

(2) Soak in dry-cleaning solvent and clean and dry thoroughly.

e. Bendix Drive. Dip, do not soak in dry-cleaning solvent and clean with soft rag. Do not soak clutch mechanism as it is sealed and cannot be repacked with grease. Dry with compressed air.

f. Miscellaneous Parts. Soak in dry-cleaning solvent and clean thoroughly.

115. INSPECTION AND TEST OF COMPONENTS.

a. Frame and Field.

(1) Inspect frame and field for worn, cracked or frayed insulation, corroded or burned terminals and for loose or corroded connections. All connections must be clinched and soldered. Repair or replace parts affected if above conditions are found (par. 116 a).

(2) Install new brushes if brushes are oil soaked or worn to less than 5/16 inches in length, or if brush leads are broken and frayed (par. 116 a).

(3) Make sure insulated brushes are not touching frame, pole pieces or grounded brushes and touch test probes to battery stud and to ground terminal stud. If lamp lights remove nut and washers from

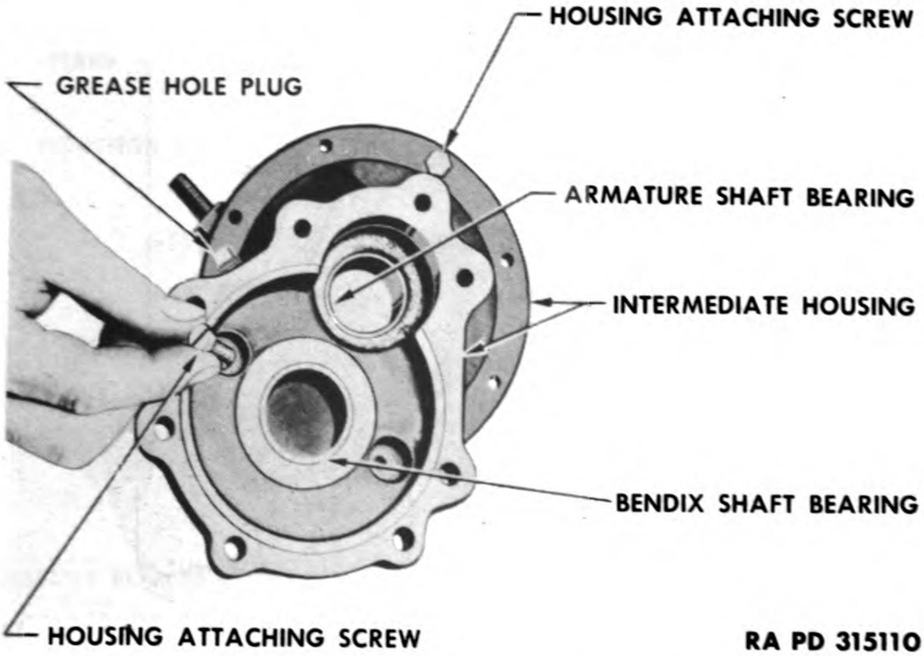


Figure 148—Intermediate Housing for MBD 4007, A, B and MBD 4010, A Cranking Motors

insulated terminal stud and press stud out of frame. Remove insulating washer and bushing. Touch probes to field coil terminal and ground. If coils are grounded discard frame and field. Install terminal post, using new insulation.

(4) Inspect all leads, windings, and connections, in field coil assembly to make sure they are clinched and soldered and no breaks or partial breaks are present. If in doubt as to connections clinch and solder using rosin core solder. Install new brushes or terminals if necessary par. 116 a) or discard frame and field assembly if field coils are at fault.

b. Armature.

(1) Inspect to make sure all coils are pressed into core slots and all are staked and soldered to commutator risers. Stake and solder if

necessary (par. 116 **b**). Discard armature if core is badly scored, if windings are loose, or if wear is evident on bearing seats. Discard armature if splines or gear teeth are unevenly worn or rough. Turn down commutator if rough or worn (par. 116 **b**).

(2) Touch one test probe to core or shaft and touch other test probe to each commutator segment in turn (fig. 17). Do not touch probes to bearing or brush surface. Discard armature if grounded as indicated by lamp lighting.

(3) Place armature on growler, hold thin steel strip on core and rotate armature slowly (fig. 18). Discard armature if shorted as indicated by steel strip becoming magnetized.

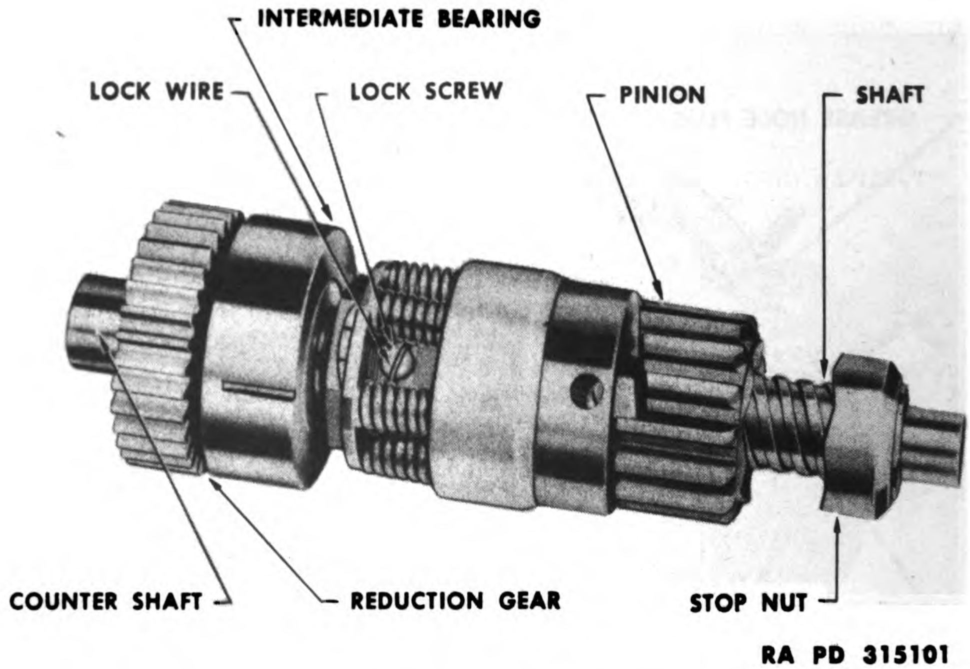


Figure 149—Bendix Installed on Bendix Drive Shaft

(4) Mount armature with bearing seats on "V" blocks and place dial indicator with plunger against and perpendicular to commutator (fig. 19). Rotate armature slowly and read total runout. Turn down commutator if total indicator reading is more than 0.003 inches (par. 116 **b**).

c. Commutator End Head.

(1) Discard head or brush plate if cracked or distorted. Discard brush springs if distorted or corroded. Discard felt pad if torn or gritty.

(2) Clamp armature in padded vise and install thrust washer and head on shaft. Feel side play. If any side movement can be felt install new bearing (par. 116 **c**). Remove head from armature.

(3) Install brush plate on head. Install brush springs, spacers and

clips. Check each brush holder for grounds with test probes. Discard brush plate if grounds are present.

(4) Clamp armature in padded vise and install thrust washers and head on commutator end of shaft. Install two new brushes in one brush holder. Discard brush plate if brushes are not in perfect alinement with commutator segments or if brushes do not slide easily. Hook tension gage under each brush spring and pull on a line parallel to face of brush (fig. 133). Take reading just as spring leaves brush. Adjust tension to 40 to 50 ounces by bending spring at point where it enters spring post. Repeat this inspection and test on all four brush holders. Install new brush spring if tension cannot be adjusted to 40 to 50 ounces.

d. Pinion Housing, Intermediate Bearing, and Intermediate Housing.

(1) Replace if cracked.

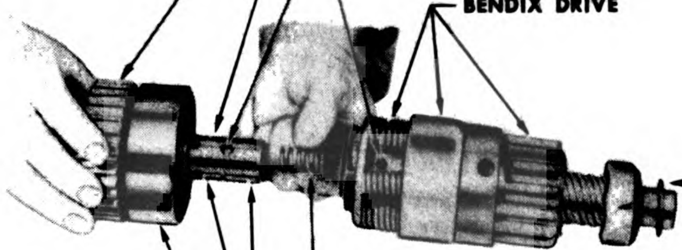


Figure 150—Installing Bendix on Bendix Drive Shaft

(2) Install intermediate bearing on shaft and feel side play. Install new bearing if any side play can be felt (par. 116 d).

(3) Install Bendix shaft in pinion housing bearing. If any side play can be felt install new bearing on MBD 4008 (par. 116 d) or replace housing on MBD 4007, A, B and MBD 4010, A.

(4) Install shafts in intermediate housing bearings and feel side play. Install new bearings if any side play can be felt (par. 116 d).

(5) Discard oil seal if leather is stiff or ragged.

e. Bendix Drive. Replace drive if springs or pinion teeth are broken or if wear is evident on bearing surface. Turn the pinion on shaft. Replace Bendix if pinion does not turn freely with only the antidrift spring resisting movement.

f. Reduction Gears. Install new gears if wear is uneven or excessive or if teeth are broken (pars. 116 **b** and 116 **f**).

g. Miscellaneous Parts. Replace screws, washers, and other small parts if not in good condition. Place cover band around motor and inspect to make sure it fits tightly against frame. Replace band if it cannot be straightened to make a tight fit. Replace terminal or heat shield if threads are stripped or if bent beyond repair.

116. REPAIR AND REBUILDING OF COMPONENTS.

a. Frame and Field.

(1) Replace frame and field if coils are faulty. Clinch and solder loose connections, using rosin core solder.

(2) Unsolder and unclinch worn brushes from field coil and ground terminals. Insert new brush lead in terminal, clinch tightly and solder with rosin core solder. Be sure all connections are strong mechanically and low resistance electrically.

(3) Install new terminal studs or insulation if necessary. Tighten nuts on studs, then cross stake ground terminal.

b. Armature.

(1) Replace armature if shaft is worn or bent, if core is badly scored, if windings are grounded or shorted, if commutator is badly burned or scored, or if gear or splines are worn excessively.

(2) Stake and solder loose windings to commutator risers. Use rosin core solder and be careful not to short across bars. Check for grounds and shorts after soldering (par. 115 **b**).

(3) If commutator is rough or worn or if runout exceeds 0.003 inch place armature in lathe. Mount armature on bearing seats and not on shaft centers (fig. 22). Take light cuts until commutator is cleaned up. Remove all burs with 2/0 flintpaper (fig. 23). Undercut mica segments to a depth of 1/32 to 3/64 inch (fig. 24). Cut must be square and free from burs (fig. 25). Check armature for shorts (par. 115 **b**).

c. Commutator End Head. Press worn bearing out of head with bolt or arbor that rests on bearing but does not mar bearing bore. Install new bearing on 0.6265-inch diameter arbor and press into place so that bearing is flush with bearing bore on inside of head. Install brush plate, springs, spacers, and clips, on head.

d. Pinion Housing, Intermediate Bearing, and Intermediate Housing. Press out worn bearings with bolt or arbor that rests on bearing but does not mar bearing bore. Install new bearing on an arbor of correct diameter to give specified bearing size (par. 119 **b**). Install bearing in plate or housing flush at end noted (par. 119 **b**).

e. Bendix Drive. There are no repairs of the Bendix drive except complete replacement.

f. Bendix Shaft (if pertinent). If gear is worn or broken press shaft out of gear. Press new gear on shaft so that it is exactly 1 35/64 inch from end of shaft to center of gear. Be sure Woodruff key is in place.

g. Miscellaneous Parts. Straighten cover band and heat shield if necessary. Glue cork lining to inside of band.

117. ASSEMBLY.

a. Lubrication. Soak all absorbent bronze bearings and felts in engine oil (SAE 30) and drain off excess oil. Apply a thin coat of engine oil (SAE 30) to shaft bearing seats. Soak oil seal in engine oil (SAE 10) then drain thoroughly and wipe off outside of seal.

b. Install Bendix and Pinion Housing.

(1) On MBD 4008 install two thrust washers on drive end of armature shaft.

(2) Press oil seal into intermediate bearing and install bearing on shaft. Install Woodruff keys (if pertinent).

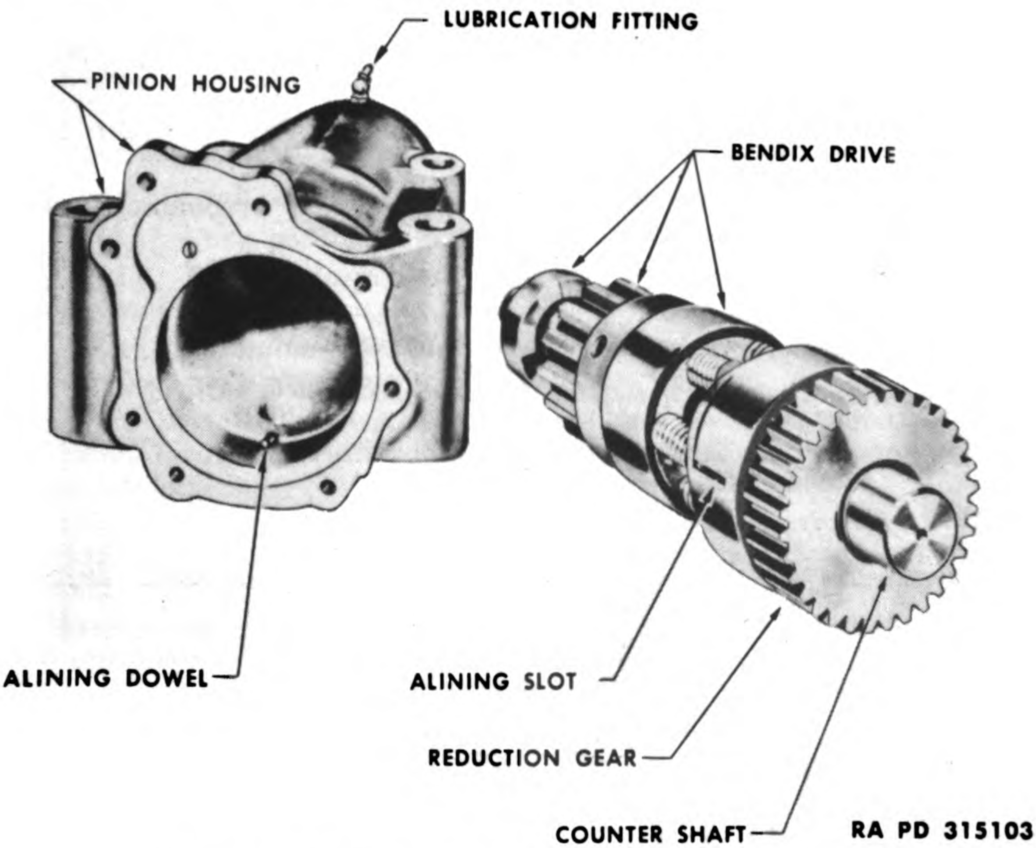


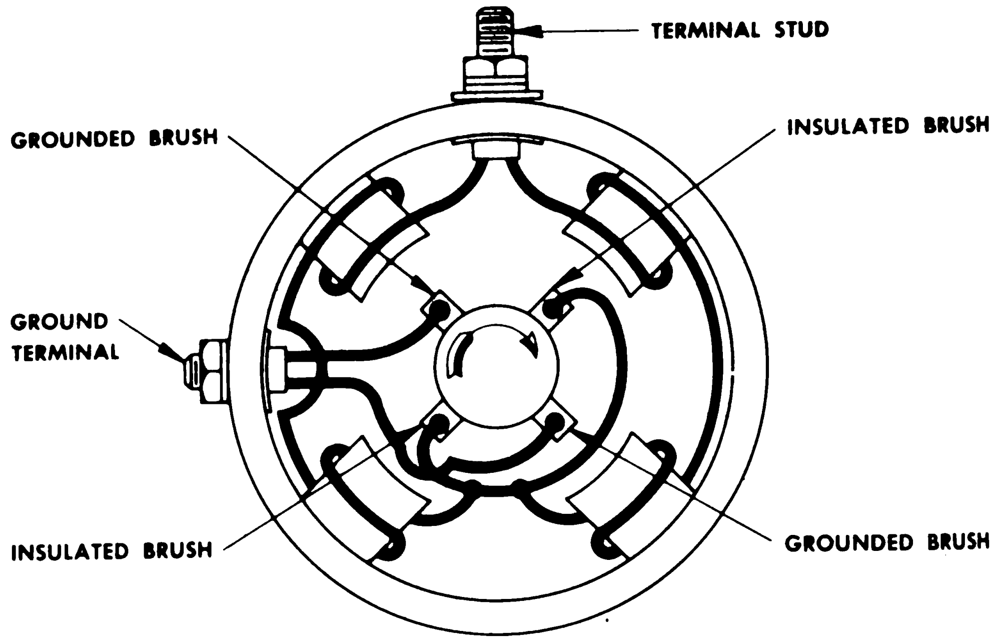
Figure 151—Installing Bendix in Pinion Housing

(3) Install spring in Bendix (MBD 4007, A, B and MBD 4010, A) (fig. 150). Line up splines or key and press Bendix drive on shaft. Install lock screw. Tighten screw and slip lock ring into screw slot (fig. 149).

(4) Insert Bendix into pinion housing. On MBD 4007, A, B and MBD 4010, A install thrust washer on drive end of Bendix shaft. Turn intermediate bearing so slot is alined with dowel pin and press bearing plate into housing (fig. 151).

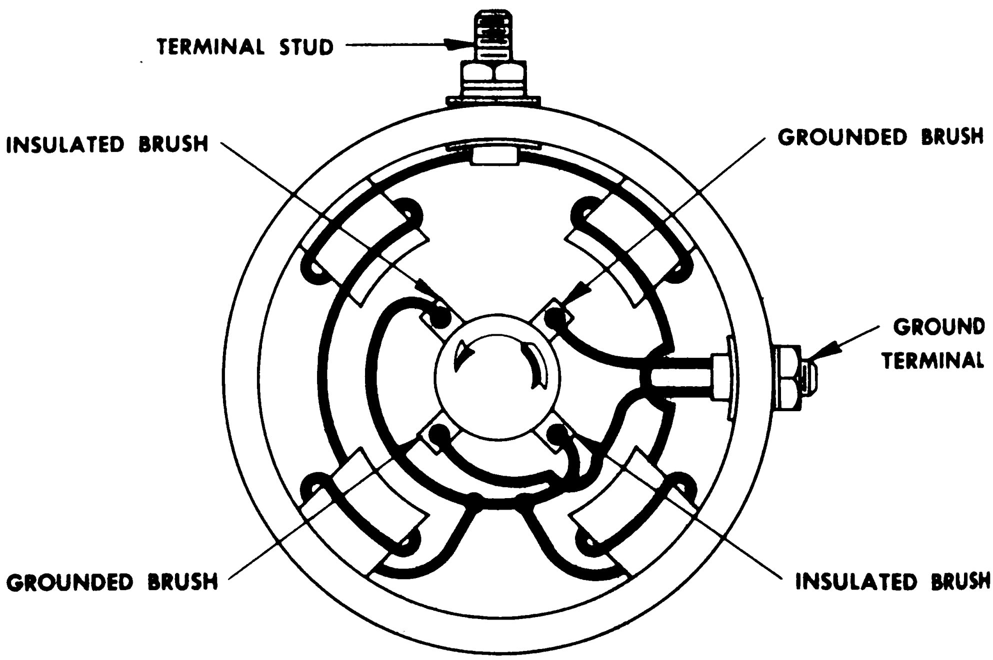
c. Install Armature.

(1) Insert armature in frame and field.



VIEWED FROM COMMUTATOR END

INTERNAL WIRING OF MBD-4007, A, B AND MBD-4010, A MOTORS



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INTERNAL WIRING OF MBD-4008 MOTOR

Figure 152—Internal Wiring Diagrams of Group 3 Motors

(2) On MBD 4007, A, B and MBD 4010, A, install thrust washer and intermediate housing on drive end of shaft.

(3) Install housing attaching screws and lock washers but do not tighten.

d. Install Commutator End Head.

(1) Place fiber thrust washer for controlling end play on commutator end of shaft. Place steel washer and commutator end head on shaft. Turn head so that alining marks made before disassembly are alined and install commutator end head attaching screws and lock washers.

(2) Hit frame a few sharp blows with soft hammer as the commutator end head attaching screws and intermediate or pinion housing screws are tightened.

(3) Lock wire the commutator end attaching screws, brush plate attaching screws, and the housing attaching screws.

e. Install Reduction Gears (if pertinent).

(1) Press corks into holes over two intermediate housing screws.

(2) Place three ounces of high melting point grease around teeth of gears.

(3) Assemble gasket and pinion housing on motor. Install, tighten, and lock wire attaching screws and lock washers.

f. Install Brushes. Make sure brush leads are not twisted and install insulated brushes in opposite holders. Install grounded brushes in holders.

118. TESTS AND ADJUSTMENTS.

a. Check Rotation. Connect motor terminal and frame to battery and note the direction of rotation. If the motor does not turn clockwise at drive end, disconnect motor and remove brushes from holders. Install brushes in holders 90 degrees from original installation.

b. Test Motor (par. 112 c).

119. FITS, TOLERANCES, AND SPECIFICATIONS.

a. General.

Poles—4.

Brushes—8.

Bearings

MBD 4007, A, B, 4010, A—4 absorbent bronze and one plain bronze.

MBD 4008—3 absorbent bronze.

Lubrication—Add three to five drops of engine oil (SAE 30) to oiler in commutator end head and lubricate outer pinion housing bearing with pressure gun every 100 hours of operation. Every 300 hours remove pipe plug from intermediate housing and add ½ ounce of high temperature grease. At overhaul, soak bearings and felts in engine oil (SAE 30) and pack gear reduction chamber with three ounces of high temperature grease.

b. Mechanical.

Rotation—Clockwise at drive end.
Brush Length (new)—3/4 inch.
Brush Length (worn)—3/8 inch minimum.
Commutator Diameter (new)—1.683 to 1.693 inches.
Commutator Diameter (worn)—1.5 inches minimum.
Brush Spring Tension—40 to 50 ounces with new brushes.
End Play—0.005 inch to 0.030 inch.
Commutator Runout—0.003 inch maximum.
Commutator Mica Undercut—1/32 to 3/64 inch.
Shaft Diameter (new)
  Commutator end—0.6245 to 0.625 inch.
  Intermediate—0.9990 to 0.9995 inch, 1.1225 to 1.123 inches or 1.2485 to 1.249 inches.
  Drive end—0.7495 to 0.750 inch or 0.9355 to 0.936 inch.
Bearing Diameter (new)
  Commutator end—0.626 to 0.627 inch.
  Intermediate—1.0005 to 1.0015 inches, 1.125 to 1.126 inches or 1.251 to 1.252 inches.
  Drive end—0.751 to 0.752 inch or 0.938 to 0.939 inch.
Bearing Assembly
  Commutator end—Flush at inner end.
  Intermediate Housing
    Armature shaft bearing—Flush at motor end.
    Bendix shaft bearing—Flush at Bendix end.
  Intermediate Bearing Plate—Flush at motor end.
  Drive end—Flush at both ends.

c. Electrical.

Rated volts—24 volts.
Starting Switch—Separate.
Clutch Type—Solid shaft, right hand, clutch type Bendix.
Internal Wiring Diagram—Figure 152.
Test Wiring—Figure 127.
No-Load Draw and Speed
  MBD 4007, A, B, MBD 4010, A
    20.0 volts, 70 maximum amperes, 1,480 minimum revolutions per minute.
  MBD 4008
    20.0 volts, 65 maximum amperes, 5,300 minimum revolutions per minute.
Stall Torque and Current
  MBD 4007, A, B, MBD 4010, A
    4.0 volts, 400 maximum amperes, 74-minimum foot pounds.
  MBD 4008
    4.0 volts, 380 maximum amperes, 21-minimum foot pounds.

CHAPTER 6

GENERAL ELECTRICAL EQUIPMENT

Section I

IGNITION COILS

120. DESCRIPTION AND DATA.

a. Description.

(1) An ignition coil has two windings, one the primary winding which consists of a comparatively few turns of heavy wire and the secondary winding which consists of many turns of very fine wire. The secondary winding is wound on a soft iron core while the primary winding is wound around the outside of the secondary winding. A soft iron shell encloses the outside of both windings and serves to complete the magnetic circuit.

(2) The function of an ignition coil is to transform the low voltage energy supplied by the battery into the high voltage energy necessary to jump the spark plug gap. Whenever current is built up and broken in the primary winding a voltage is induced in the secondary winding. The design of a coil is such that the induced voltage will be sufficiently high to produce a spark at the spark plug.

(3) Ignition coils are marked with the rated voltage and have the part number stamped either on the coil bracket or on the bottom plate. For model numbers of ignition coils, see paragraph 1.

b. Data.

Rated voltage.

CE Type—6 volts.
CF Type—12 volts.
CM Type—12 volts.
CO Type—24 volts.
CP Type—12 volts.
IG Type—6 volts.

Current Draw—after ½ minute at specified voltage with coil at room temperature.

CE Type—5.2 amperes at 6.3 volts. Flash—5.4 to 5.5 amperes at 6.3 volts.

CF Type—2.4 amperes at 12.0 volts. Flash—2.47 to 2.52 amperes at 12.0 volts.

CM Type—2.3 amperes at 12.5 volts. Flash—2.97 to 3.03 amperes at 12.5 volts.

CO Type—2.7 amperes at 24.0 volts. Flash—2.97 to 3.03 amperes at 24.0 volts.

CP Type—2.5 amperes at 12.0 volts. Flash—2.97 to 3.03 amperes at 12.0 volts.

IG Type—4.8 amperes at 6.3 volts. Flash—5.47 to 5.52 amperes at 6.3 volts.

Resistance unit.

CE Type—None.
CF Type—None.
CM Type—1.0 to 1.10 ohms.
CO Type—5.3 to 5.52 ohms.
CP Type—1.0 to1.10 ohms.
IG Type—None.

121. CLEANING, INSPECTING, AND TESTING.

a. Cleaning. Wipe outside of coil with cloth dampened in dry-cleaning solvent. Clean terminals with 2/0 flintpaper.

b. Inspecting.

(1) Inspect for dents and cracks and replace coil if cracked or if terminals are badly corroded.

(2) On lock type coils unclinch ears holding coil bottom to coil. Remove primary lead screw and take lock and cable off coil. Inspect lock to make sure key operates satisfactorily.

c. Testing.

(1) Connect battery of rated voltage (par. 120 **b**) and variable resistance in series with two coil primary terminals. Connect voltmeter across primary terminals. On CM, CO and CP type coils include resistance unit in circuit. Adjust voltage to specified value and allow current to flow for ½ minute, then take reading. Open then close battery switch, adjust voltage to value specified for flash reading and read ammeter. If current is not within specifications (par. 120 **b**) replace CE, CF, CM and IG type coils or overhaul CO and CP type coil (pars. 122 to 128).

(2) Connect ammeter, variable resistance and 6 volt battery in series with AM terminal on lock switch and coil primary lead. Connect voltmeter from AM terminal to lead terminal. Turn "Ign" switch on, adjust variable resistance to give 5 ampere current and read voltmeter. Replace lock switch and cable if voltmeter reading is more than 0.05 volts. Change connections so test is made from AM terminal to GA terminal. Discard lock switch and cable if voltage loss is larger than 0.05 volts at 5 amperes.

(3) With coil tester compare coil to standard coil. Make comparison test both hot and cold by measuring length of spark gap. Heat coil and standard coil by connecting to battery of rated voltage for 5 minutes. Replace coil if results of comparison test show coil to be inoperative or weak.

122. DISASSEMBLY (CO and CP type only).

a. Remove Resistance Unit. Remove two screws, lock washers, and plain washers. Remove nut and washer from primary terminal and disconnect lead. Pull cover and resistor from coil.

b. Remove High Tension Terminal. Take off coil knob and rubber grommet.

123. CLEANING OF COMPONENTS (CO and CP type only).

a. Cover, Resistor and Coil. Clean coil knob, cover, resistor assembly, screw, and washers in dry-cleaning solvent. Dry thoroughly.

b. Terminals. Clean with 2/0 flintpaper.

c. Bushings and Grommets. Clean with soft rag.

124. INSPECTION OF COMPONENTS (CO and CP type only).

a. Terminals and Lead. Inspect for loose, corroded or pitted terminals. Install new terminals if not in good condition (par. 125). Discard resistor assembly if lead is broken or frayed or terminals are loose (par. 125). Discard grommets and bushings if ragged or torn.

b. Resistor. Measure resistance of resistor unit. Install new resistance unit if resistance is not within specification (pars. 120 **b** and 125).

125. REPAIR AND REBUILDING OF COMPONENTS (CO and CP type only).

a. Resistor. Remove resistor mounting nut and washers. Cut resistor lead and pull resistor assembly from cover. Mount new resistor on cover. Install plain washer, lock washer and nut on screw and tighten. Thread lead through grommet in side of cover. Clinch and solder terminal to lead.

126. ASSEMBLY (CO and CP type only).

a. Install Resistor. Place cover and resistor on coil and install two screws, lock washers, and plain washers. Connect resistor lead to positive primary terminal and install lock washer and nut.

b. Assemble High Tension Terminal. Install grommet and coil knob.

127. TESTS.

a. Refer to paragraph 121 **c**.

128. TOLERANCES AND SPECIFICATIONS.

a. Refer to paragraph 120 **b**.

CHAPTER 6

GENERAL ELECTRICAL EQUIPMENT (Cont'd)

Section II

SWITCHES—GROUP 1

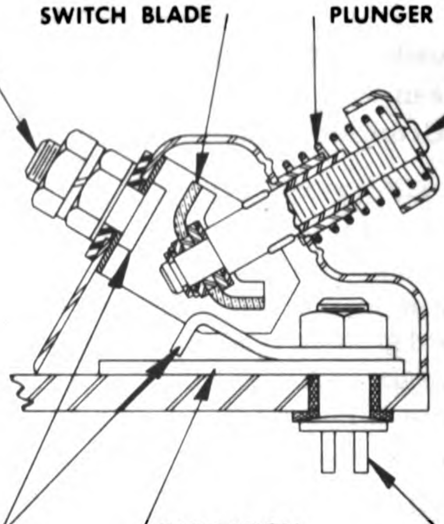

Figure 153—SW 2813 and SW 2677A Starting Switches

129. DESCRIPTION AND DATA.

a. Description.

(1) SW 2677A and SW 2813 switches (fig. 153) are mounted on the cranking motor and open and close the starting circuit. The switch is operated by pedal action through the clutch yoke and linkage. One of the contacts is mounted on the motor terminal post while the second contact and the switch blade are inside the switch. Both contacts and the blade must be considered when inspecting and testing the switch.

(2) SW 4000 series switches (fig. 154) are mounted on the floor or panel and are operated directly to close and open the starting circuit. These switches are completely closed and cannot be repaired.

(3) XA-type switches are push button type and are connected in the control circuit of a solenoid starting switch. XA 456 and XA 532 have two terminals and make and break one control circuit. XA 570

has five terminals and is connected in the starting circuit to change two six-volt batteries from parallel operation to series operation for the 12-volt cranking motor. XA 572 switch has four terminals and is used to open and close two separate circuits to control two step cranking motor operation.

(4) For model numbers of group 1 switches, see paragraph 1.

b. Data.

Type—Manually operated.

SW switches—starting circuit.

XA 456 and XA 532—(cranking motor control circuit).

XA 570—(series-parallel cranking motor circuit).

XA 572—(two-step control circuit).

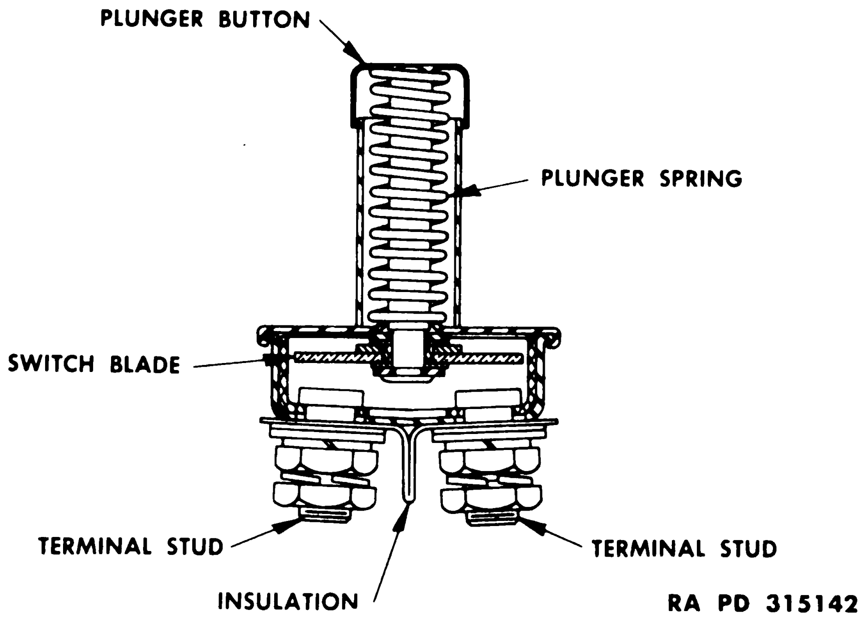

Figure 154—SW 4000 Series Starting Switches

130. CLEANING, INSPECTING, AND TESTING.

a. Cleaning. Clean outside of switch with cloth dampened in dry-cleaning solvent. Apply one or two drops of engine oil (SAE 10) to switch plunger.

b. Inspecting.

(1) Operate switch plunger by hand. Discard switch if plunger action is sluggish.

(2) On XA 570 remove fuse holder and inspect fuse and fuse insulation. Install new fuse and insulation if necessary.

c. Testing.

(1) Touch one test probe to switch case and touch other test probe to each terminal. Test each terminal with switch both open and closed. Discard switch if grounded.

(2) Touch test probes to two main switch terminals. If lamp does not go on and off when switch is operated, replace switch.

(3) On XA 572 touch test probes to BAT and S1 terminals and operate button. Touch probes to S2 and S3 terminals and operate button. Replace switch if lamp does not go on and off when button is operated.

(4) On XA 570 touch test probes to +B and –A terminals and operate plunger. Lamp must go on and off when plunger is pushed in and out; repeat same test with probes on SW terminal and fuse holder. Touch test probes to –B and –A terminals and operate plunger. Lamp must go off and on when plunger is pushed in and out; repeat this test with probes touching +B terminal and fuse holder. Touch test probes to +B and SW terminals. Lamp must not light with plunger in either position. Repeat this test with probes on –A terminal and a ground on switch case and also with probes on –B and a ground on switch case. Replace switch if these tests prove it shorted, grounded or open.

(5) On SW 4000 series switches and XA 570 series parallel switch, connect battery, carbon pile rheostat and ammeter in series with main switch terminals. Connect voltmeter to two main switch terminals (–A and +B terminals on XA 570). Close switch and adjust carbon pile to give 100 amperes current. Read voltmeter. Replace switch if voltage reading is in excess of 0.05 volts.

CHAPTER 6

GENERAL ELECTRICAL EQUIPMENT (Cont'd)

Section III

SWITCHES—GROUP 2

131. DESCRIPTION AND DATA.

a. **Description** (figs. 155, 156, and 157).

(1) Group 2 switches are connected in the starting circuit and are operated electrically by solenoid action. A remotely mounted push button controls the energizing current. Besides making and breaking the starting circuit the SS 4200 series switches shift the starter pinion into mesh with the flywheel teeth.

(2) SS 4000, SS 4500 and WSE type switches have a single winding while SS 4200 series switches have two windings. One of the windings on the latter type consists of heavy wire and is energized only until the starter pinion has been shifted. The other winding is energized during the entire starting cycle and serves to hold the contacts closed and the pinion in the meshed position. A relay is mounted within the switch cover and is connected in the control circuit. This eliminates the necessity of having the large solenoid current flowing through the push button.

(3) SS series switches have the part number and rated voltage stamped on the switch base. WSE series switches have the part number stamped either on the name plate mounted on the side of the solenoid or on the solenoid cover.

(4) For model numbers of group 2 switches, see paragraph 1.

b. Data.

Unit	Rated Voltage	Control Circuit	Internal Wiring	Current Draw Volts	Current Draw Amperes	Closing Voltage	Opening Voltage
SS 4001	6	10–32 term to grd	Fig. 158	6.0	2.9 to 3.3	3.0 to 4.0	0.5 to 2.0
SS 4022	12	10–32 to bat term	Fig. 158	12.0	1.5 to 1.7	8.5 max	1.5 to 4.0
SS 4205	6	2—10–32 terms	Fig. 158	*	*	*	*
SS 4209	12	2—10–32 terms	Fig. 158	*	*	*	*
SS 4209A	12	2—10–32 terms	Fig. 158	*	*	*	*
SS 4210	12	2—10–32 terms	Fig. 158	*	*	*	*
SS 4505	24	2—10–32 terms	Fig. 158	12.0	1.5 to 1.7	12.5–15.5	1.5 to 2.0
WSE 4001	24	2—10–32 terms	Fig. 158	24.0	3.1 to 3.5	10.0 max	0.5 to 3.0
WSE 4001A	24	2—10–32 terms	Fig. 158	24.0	3.1 to 3.5	10.0 max	0.5 to 3.0
WSE 4002	24	2—10–32 terms	Fig. 158	24.0	3.1 to 3.5	10.0 max	0.5 to 3.0
WSE 4003	24	10–32 term to grd	Fig. 158	24.0	3.1 to 3.5	10.0 max	0.5 to 3.0

* Current Draw—"Holding" coil only:
SS 4205—7 to 8 amperes at 3.0 volts.
SS 4209, A, 4210—2.1 to 2.5 amperes at 5.0 volts.

Current Draw ("Pull in" coil only):
SS 4205—27 to 30 amperes at 3.0 volts.
SS 4209, A, 4210—16.7 to 19.5 amperes at 5.0 volts.

Relay winding resistance:
SS 4205—7.5 to 8.3 ohms.
SS 4209, A, 4210—29.0 to 32.2 ohms.

Relay closes:
SS 4205—3.5 to 4.5 volts.
SS 4209, A, 4210—7.0 to 9.0 volts.

Relay opens:
SS 4205—1.5 to 2.5 volts.
SS 4209, A, 4210—3.0 to 5.0 volts.

132. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Wipe outside of switch with cloth dampened in dry-cleaning solvent and dry thoroughly.

(2) On SS 4000 and SS 4500 series switches unscrew dust cover on end of switch. Blow off plunger with clean dry compressed air.

(3) On SS 4200 remove screws from control terminals and take out two cover screws. Pull cover from switch. Remove clamp, boot, and

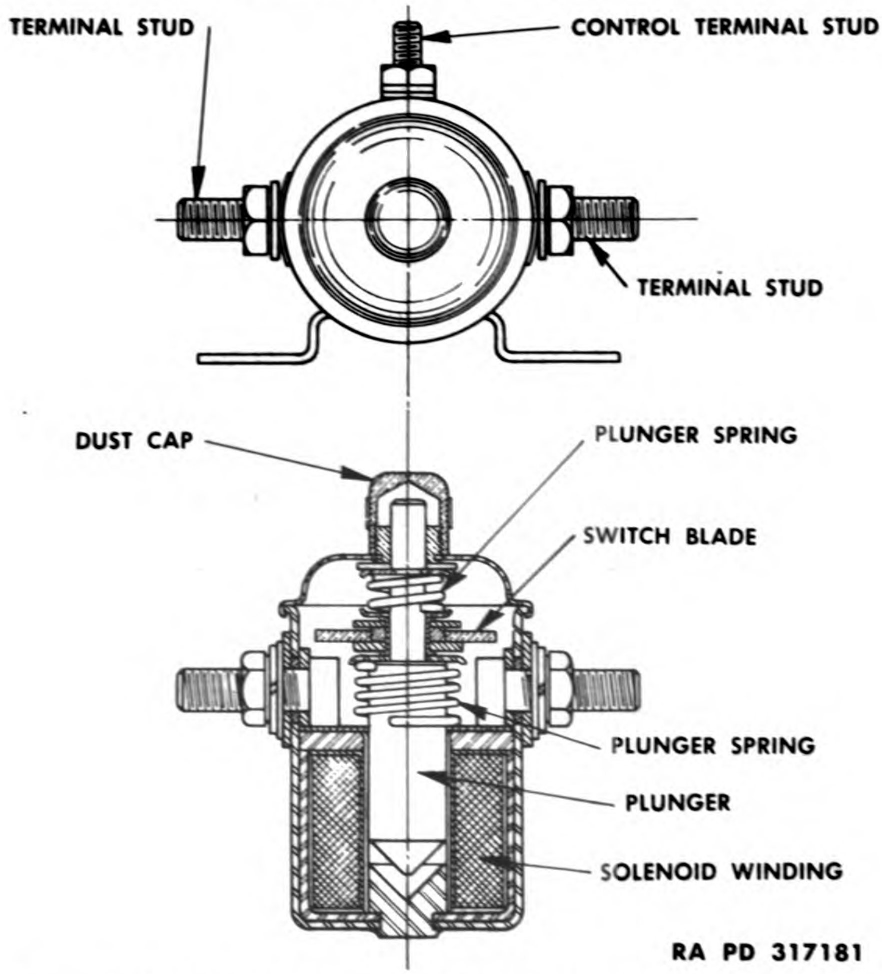

Figure 155—SS 4000 and SS 4500 Series Starting Switches

plunger, from switch. Blow off relay and switch with clean dry compressed air. Clean relay contacts with linen tape and carbon tetrachloride. Draw tape dampened with carbon tetrachloride between contacts, then repeat with dry tape to remove any residue.

b. Inspecting.

(1) Inspect case, cover, and bracket, for dents and cracks. Disassemble switch and discard damaged parts (pars. 133 to 139). On SS-type switches move plunger by hand. Discard plunger or switch if plunger does not slide smoothly.

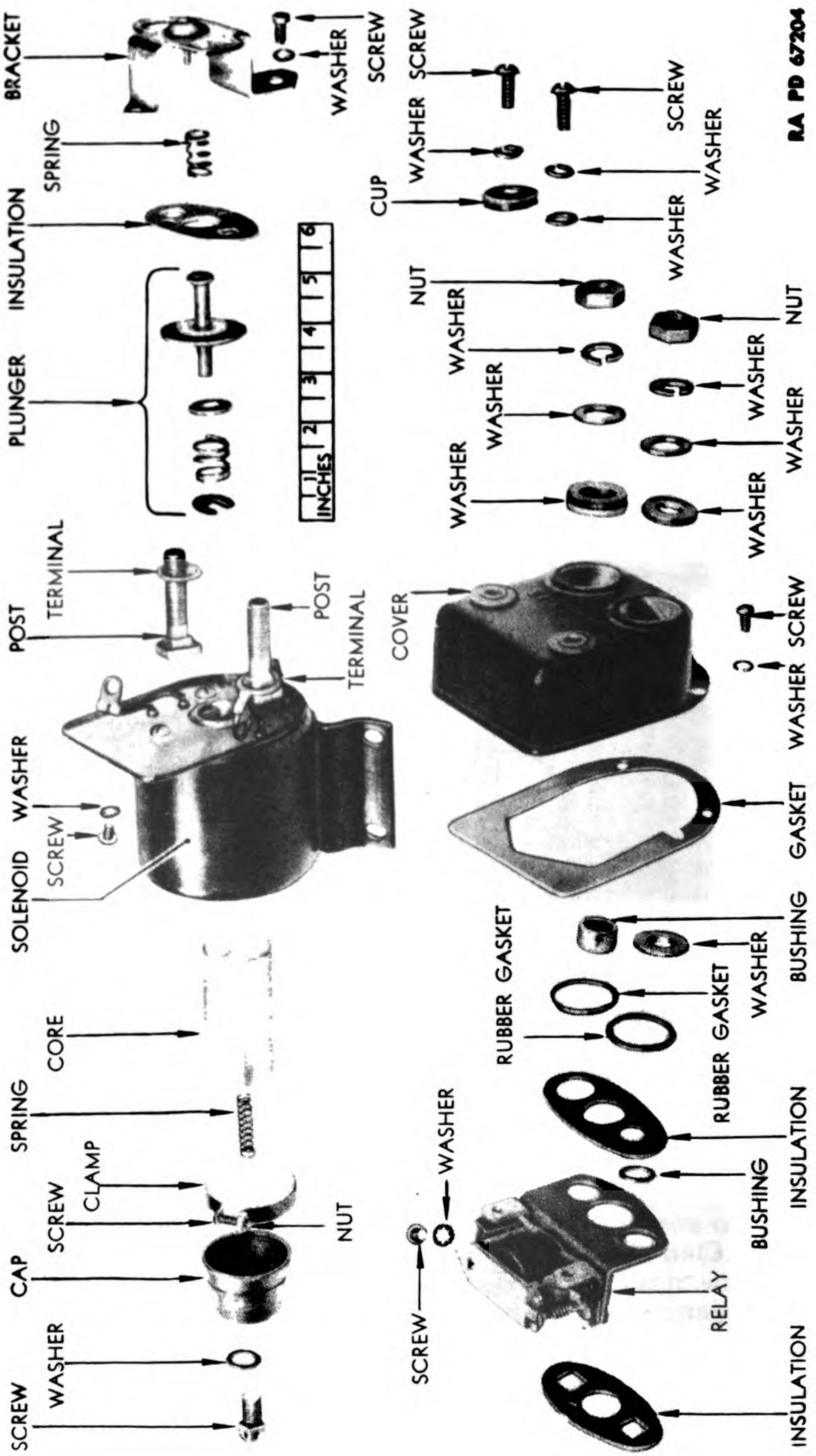

Figure 156—SS 4200 Series Starting Switches

SWITCHES—GROUP 2

(2) On SS 4200 series switches inspect switch and relay contacts. If main contacts are burned or pitted overhaul switch and install new contacts (pars. 133 to 139). If relay contacts are burned or pitted file with contact point dresser (41-D-1410) (fig. 159). File lengthwise and parallel to armature. After filing, clean contacts with carbon tetrachloride and linen tape.

(3) Inspect for loose screws, nuts and terminals. Tighten and repair loose connections.

c. **Testing.**

(1) On SS 4001, 4002, 4505, and all WSE types, connect battery of rated voltage, variable resistance and ammeter in series with the control circuit (par. 131 **b**). Connect voltmeter across control circuit. Adjust voltage to specified value (par. 131 **b**) and read ammeter. If current is not within limits (par. 131 **b**) replace SS-type switches or overhaul WSE-type switches (pars. 133 to 139).

(2) On SS 4200 series switches connect ammeter, battery of rated voltage and carbon pile rheostat in series with terminal at relay stationary contact and switch base. Adjust voltage to specified value for holding coil draw (par. 131 **b**) and read ammeter. If current is not within specifications overhaul switch (pars. 133 to 139). Connect ammeter, battery and carbon pile rheostat in series with terminal at relay stationary contact and left-hand large switch terminal. Adjust voltage to value specified for "pull in" coil (par. 131 **b**) and read ammeter. If current is not within limits, overhaul switch (pars. 133 to 139).

(3) Connect battery of rated voltage and variable resistance in series with control circuit (par. 131 **b**). Connect voltmeter across control circuit. Insert all resistance in circuit, then decrease resistance slowly until switch or relay closes. Note closing voltage. Increase resistance and note opening voltage. Replace SS 4001, 4022, 4505 and WSE-type if switch does not close and plunger seal within specified limits (par. 131 **b**). On SS 4200 series switches adjust relay closing voltage to specified limits (par. 131 **b**) by bending armature stop and adjust opening voltage by bending lower spring hanger. If relay cannot be adjusted, overhaul switch and install new relay (pars. 133 to 139). Do not adjust contact gap, when open, to less than 0.025 inch.

(4) Connect carbon pile rheostat, 200 ampere ammeter and battery in series with two large switch terminals. Connect voltmeter across switch terminals. Install plunger in SS 4200 series switches. Connect control circuit (par. 131 **b**) to battery to close switch. Adjust carbon pile rheostat to give 100 amperes current and read voltmeter. If voltage is in excess of 0.4 volts for SS-type or 0.05 volts for WSE-type disassemble SS 4200 and WSE-type switches and install new main contacts (pars. 133 to 139). On SS 4001, 4022 and SS 4504 replace switch if voltage is over 0.4 volts.

(5) Apply a thin film of engine oil (SAE 10) to switch plunger on SS switches and install cover on switch. Do not lubricate WSE-type switches. Install shield covers.

(6) Mount switch on starting motor and install connectors and linkage. Adjust linkage (par. 94 **c**). Connect motor to battery with

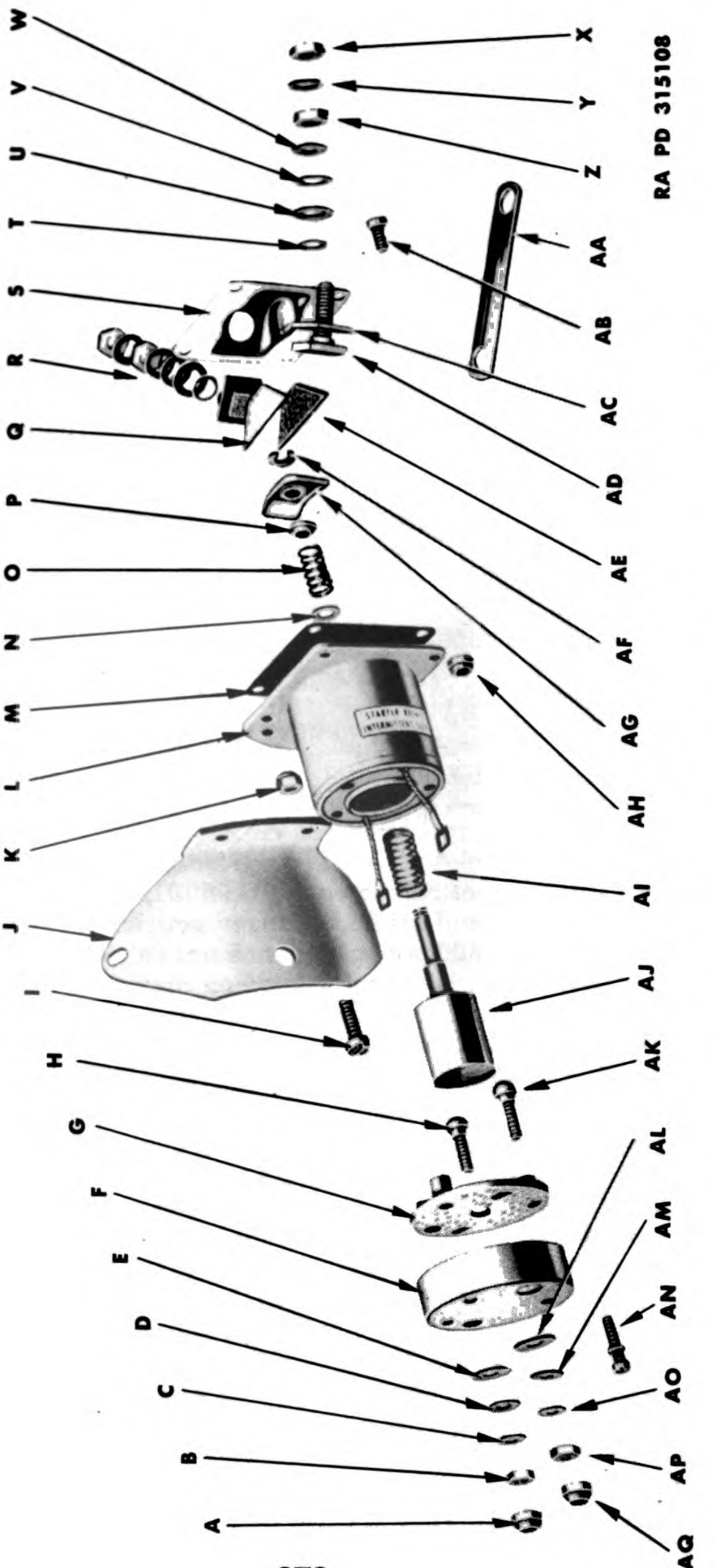

Figure 157—WSE 4000 Series Starting Switches Disassembled

A—LOCK NUT
B—NUT
C—LOCK WASHER
D—PLAIN WASHER
E—INSULATING WASHER
F—COVER
G—TERMINAL INSULATION
H—CONTROL TERMINAL STUD
I—MOUNTING SCREW
J—MOUNTING BRACKET
K—MOUNTING NUT
L—SOLENOID AND BASE ASSEMBLY
M—COVER INSULATION
N—SPRING RETAINING WASHER
O—SPRING
P—SPRING RETAINING BUSHING
Q—INSULATOR
R—MOTOR TERMINAL STUD PARTS
S—SWITCH BLADE HOUSING
T—INSULATING WASHER
U—WASHER
V—PLAIN WASHER
W—LOCK WASHER
X—TERMINAL STUD NUT
Y—LOCK WASHER
Z—TERMINAL STUD NUT
AA—SWITCH TO MOTOR CONNECTOR
AB—SWITCH BLADE HOUSING SCREW
AC—TERMINAL STUD INSULATION
AD—BATTERY TERMINAL STUD
AE—INSULATOR
AF—CLIP
AG—SWITCH BLADE
AH—SWITCH BLADE HOUSING NUT
AI—SPRING
AJ—MOVABLE CORE
AK—CONTROL TERMINAL STUD
AL—INSULATING WASHER
AM—PLAIN WASHER
AN—COVER SCREW
AO—LOCK WASHER
AP—NUT
AQ—LOCK NUT

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Legend for Figure 157—WSE 4000 Series Starting Switches

starting switch in circuit. Connect switch control circuit to battery to close switch. If motor does not operate and pinion does not shift inspect switch and linkage for incorrect assembly.

133. DISASSEMBLY.

a. **SS 4200 Series Switches** (fig. 156). Remove control terminal screws, cover screws and cover. Remove boot clamp screw, plunger link screw, spring, boot and large plunger. Remove terminal stud nuts and washers. Take out bracket screws, disconnect relay lead and lift off bracket and relay. Remove insulation and small plunger.

b. **WSE-type Switches** (fig. 157).

(1) Remove shield cover screws and covers. Remove nuts and washers from control terminals. Remove screws and lift off control terminal cover. On WSE 4001, A, take out three screws and lift off terminal insulation. Remove control terminal insulation and control terminals.

(2) Remove four switch blade housing screws and lift off housing. Unclinch and remove plunger clip. Lift off switch blade, plunger spring, and spring retainers. Remove plunger and spring.

134. CLEANING OF COMPONENTS.

a. **Contacts and Blade.** Clean with carbon tetrachloride and rub dry with soft rag.

b. **Solenoid and Relay.** Wipe with cloth dampened in dry-cleaning solvent and blow dry with clean dry compressed air.

c. **Insulating Parts.** Wipe with cloth dampened in dry-cleaning solvent and dry thoroughly. Do not soak.

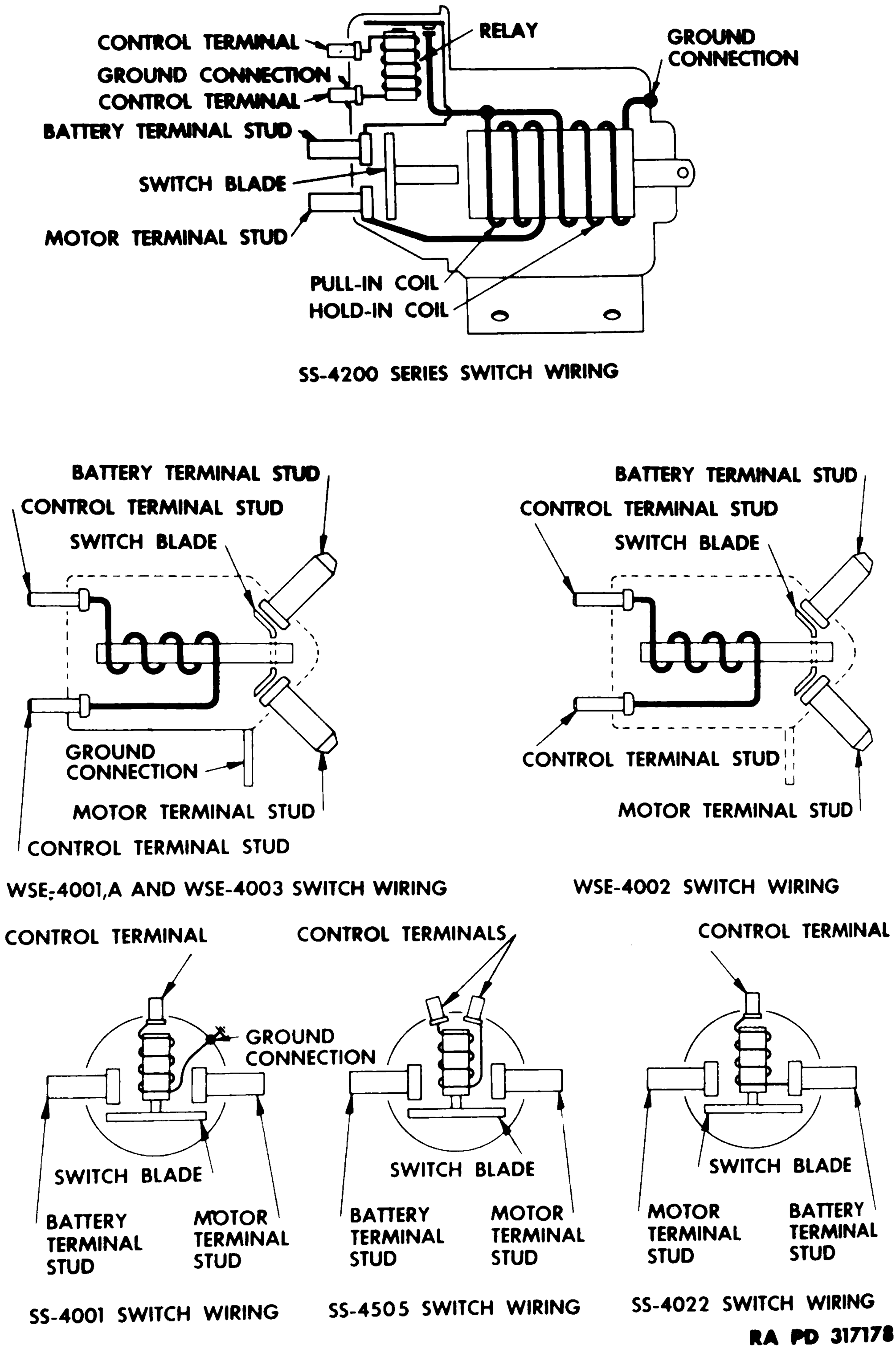

Figure 158—Internal Wiring Diagrams of Group 2 Starting Switches

d. **Metal Parts.** Soak in dry-cleaning solvent and clean and dry thoroughly.

135. INSPECTION AND TEST OF COMPONENTS.

a. **Solenoid Winding.**

(1) Connect variable resistance, battery and ammeter between the two leads of solenoid winding. Connect voltmeter to two winding leads. Adjust voltage to specified value (par. 131 **b**) and read ammeter. If current is not within limits ("pull in" coil on SS 4200) (par. 131 **b**) replace solenoid and case assembly. On SS 4200 connect ammeter, battery and variable resistance to double lead and to switch base. Adjust voltage to specified value and read ammeter. If current is not within limits for "hold in" coil (par. 131 **b**) replace solenoid and base assembly.

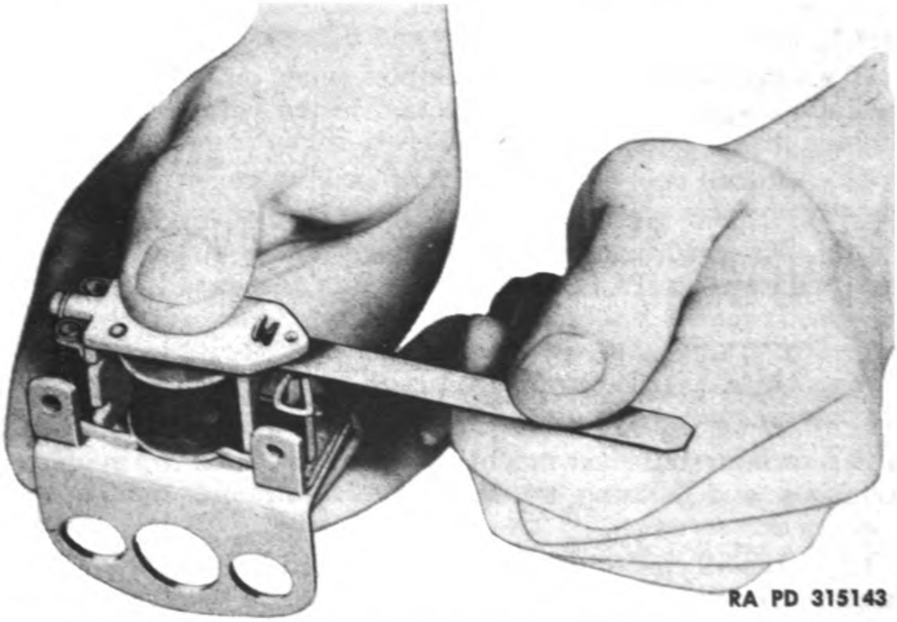

Figure 159—Filing Relay Contacts on SS 4200 Series Switches with Contact Point Dresser (41-D-1410)

(2) Replace solenoid and base if case or bracket is damaged or if core tube is rough or corroded. Clinch and solder terminals if loose.

b. **Plunger and Contacts.** Replace contacts if burned or pitted or if contacts do not make full face contact.

c. **Insulation.** Replace insulating washers, bushings and other insulating parts if oil soaked, cracked or damaged.

d. **Relay.**

(1) Measure resistance of relay winding with ohmmeter. Replace relay if resistance is not between 7.5 to 8.3 ohms for 6-volt switches or between 29.0 and 32.2 ohms for 12-volt switches.

(2) Replace relay if contacts are badly burned or pitted or if terminals and windings are loose.

136. REPAIR AND REBUILDING OF COMPONENTS.

a. **Solenoid and Base Assembly.** Clinch terminals and solder with rosin core solder. Solder ground lead to case.

b. **Plunger and Contacts.** File contacts smooth and flat so they will make full face contact. Do not leave burs.

c. **Relay.** File burned contacts with equaling file (ST 290). File lengthwise and parallel to armature (fig. 159). File just enough to smooth and clean contacts without removing every trace of pitting. Clean contacts with linen tape and carbon tetrachloride.

137. ASSEMBLY.

a. **SS 4200 Series Switches** (fig. 156).

(1) Install switch blade and plunger in solenoid. Install terminal studs in terminals and install inner insulation, spring and bracket on switch. Install two bracket screws and tighten.

(2) Install intermediate insulation, relay, insulating bushing, outer insulation, washers and bushings, and fasten with terminal stud nuts. Tighten nuts. Connect winding leads to relay terminal.

(3) Install rubber terminal stud gaskets, cover gasket, and cover. Install two cover screws, two control terminal screws, and lock washers.

(4) Insert spring in plunger, place boot on plunger, and install link screw and washer. Place plunger in switch and install and tighten boot clamp.

b. **WSE-series Switches** (fig. 157).

(1) Install switch terminals and insulation in housing and tighten nuts. Place spring on plunger and install in solenoid. Install spring retainer, spring, retainer, switch blade, and clip. Clinch clip in place. Install terminals and housing on solenoid. Install and tighten four lock washers and screws.

(2) Install control terminal studs in coil terminals. Place terminal insulation on terminal studs. On WSE 4002 and 4003, install cover and insulating washers (one insulating washer on WSE 4003). Install plain washers, lock washers, and nuts, on control terminals and tighten. Install cover, insulation holding screws, and lock washers. On WSE 4001 install terminal cover and fasten with four screws and lock washers.

138. TESTS AND ADJUSTMENTS.

a. Refer to paragraph 132 **c**.

139. FITS, TOLERANCES, AND SPECIFICATIONS.

a. Refer to paragraph 131 **b**.

CHAPTER 6

GENERAL ELECTRICAL EQUIPMENT (Cont'd)

Section IV

WINDSHIELD WIPERS

140. DESCRIPTION AND DATA.

a. Description (fig. 160).

(1) Dyneto-type windshield wipers are electric motors that drive the wiper arm through a worm gear and driving sector. The worm gear on the armature shaft drives the crank gear which has an eccentric cam mounted on the same shaft. The cam imparts a reciprocating motion to the driving sector which meshes with a gear on the wiper shaft.

(2) Wipers can be identified by the specification number stamped on the side of the mounting lug. The rated voltage and code date of manufacture are also stamped on the lug. For model numbers of windshield wipers, see paragraph 1.

b. Data.

Field Coil Draw at 70° F.

6 volt wipers—16.5 to 17.0 amperes at 6.0 volts.

12 volt wipers—5.5 to 5.8 amperes at 12.0 volts.

No-Load Draw with motor hot.

6 volt motors—3.0 amperes, 6.0 volts, 55 minimum sweeps per minute.

12 volt motors—1.5 amperes, 12.0 volts, 50 minimum sweeps per minute.

Wiper No.	Spec No.	Rated Volts	Arm Length Inches	Blade Length Inches	Sweep
28474	1340	6	8⅞	8¼	100°
28533	1361	12	7½	8¼	100°
28938	1616	12	8⅞	9	140°
28942	1617	6	8⅞	9	100°
29058	1664	6	5 13/16	7	100°
29078	1672	6	7½	10¼	100°
29118	1686	12	8⅞	9	100°
29150	1693	6	6¾	9	140°
29180	1695	6	6¾	9	140°
29192	1697	6	7½	10¼	100°
29308	1738	12	8⅞	9	140°
29366	1759	6	11	10¼	100°

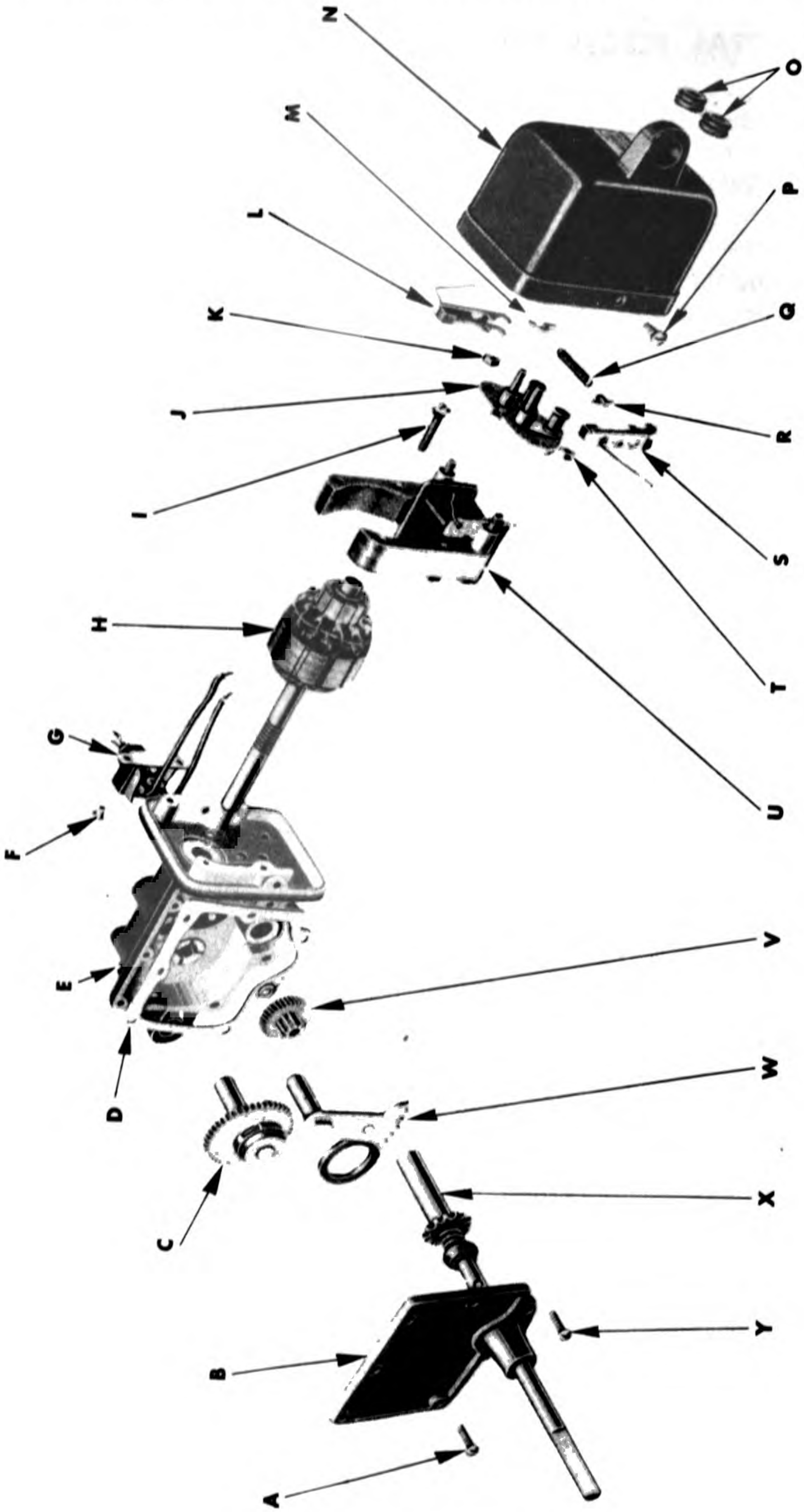

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Figure 160—Components of Windshield Wiper, Partially Disassembled

WINDSHIELD WIPERS

A—COVER SCREW
B—GEAR CASE COVER
C—CRANK GEAR ASSEMBLY
D—GASKET
E—BASE
F—SWITCH MOUNTING RIVET
G—SWITCH
H—ARMATURE
I—FIELD MOUNTING SCREW
J—TERMINAL ASSEMBLY
K—TERMINAL MOUNTING NUT
L—BRUSH AND BRUSH ARM
M—SPRING RETAINER
N—MOTOR COVER
O—RUBBER GROMMET
P—COVER SCREW
Q—BRUSH SPRING
R—SPRING RETAINER
S—BRUSH AND BRUSH ARM
T—TERMINAL MOUNTING NUT
U—FRAME AND FIELD ASSEMBLY
V—WORM GEAR
W—DRIVING SECTOR
X—WIPER SHAFT
Y—COVER SCREW

RA PD 315146B

Legend for Figure 160—Components of Windshield Wiper

141. CLEANING, INSPECTING, AND TESTING.

a. Cleaning. Thoroughly clean outside of wiper with soft cloth and dry-cleaning solvent. Do not soak.

b. Inspecting. Inspect for dents, cracks, loose screws, and corroded terminals. Overhaul wiper and replace faulty parts (pars. 142 to 148).

c. Testing. Connect fully charged battery of rated voltage, ammeter, and variable resistance, in series with two motor terminals. Connect voltmeter across motor terminals. Close test stand battery switch, turn resistance "out" and operate for ten minutes to warm motor. Adjust variable resistance to give specified voltage (par. 140 **b**). Read ammeter and count number of sweeps per minute. Overhaul wiper if current or speed is not within specifications (pars. 140 **b** and 142 to 148).

142. DISASSEMBLY (fig. 160).

a. Remove Gears. Remove seven screws and take off gear case cover and gasket. Pull wiper shaft from cover or motor. Lift out driving sector, crank gear, worm gear, and thrust washer.

b. Disassemble Motor. Remove terminal stud nut, two cover screws, and take off motor cover. Lift brush holders off mounting studs, then pull armature from motor. Take out four screws and pull frame and field away from housing.

143. CLEANING OF COMPONENTS.

a. Armature. Wipe armature with soft cloth dampened in dry-cleaning solvent. Do not soak. Sand commutator with 2/0 flintpaper. Clean dirt from between commutator bars.

b. Base and Field. Clean interior of housing with dry-cleaning solvent and soft rag. Do not soak brushes, field coil, leads or switch. Wipe field assembly, brush holders, and housing, with cloth dampened in dry-cleaning solvent.

c. Gears and Miscellaneous Parts. Soak worm gear, crank gear, driving sector, covers, gaskets, and screws in dry-cleaning solvent and clean thoroughly.

144. INSPECTION AND TEST OF COMPONENTS.

a. Armature.

(1) Replace armature if windings are loose, if commutator is burned, rough or pitted or if worm gear is badly worn.

(2) Touch test probes to core and to each commutator segment. Replace armature if lamp lights. Touch one commutator segment with test probe and touch each of the other segments with second probe. Do not touch brush surface. If lamp does not light twice when testing each bar, inspect for open circuits at commutator risers. If open circuits are found, solder with rosin core solder. Replace armature if open circuits cannot be soldered.

(3) Place armature on growler and hold thin steel strip on core. Rotate armature slowly. If short is present, steel strip will become magnetized and vibrate. Replace armature if shorted.

(4) Place armature shaft on V blocks and mount dial indicator against commutator. Rotate armature slowly. Replace armature if run-out is over 0.0005 inch.

b. Base and Field.

(1) Install new base or terminal assembly if cracked (par. 145 **b**). Try fit of each shaft in bearings, and install new base if any side play or binding can be felt. Install new brushes if brushes are oil soaked or are worn to within 1/16 inch of holder (par. 145 **b** (3)). Install new worm gear stud if stud is loose, worn, or bent. Install new brush spring if spring is distorted. Inspect all connections and solder with rosin core solder if connections are loose. Install new terminal assembly if terminals are corroded or loose.

(2) Connect an ammeter, variable resistance, and battery of rated voltage (par. 140 **b**) in series with field coil winding. It is unnecessary to disconnect winding from terminals. Connect voltmeter across field winding. Adjust voltage to specified value (par. 140 **b**) and read ammeter. Install new frame and field if current is not within limits (pars. 140 **b** and 145 **b** (4)).

(3) Touch test probes to two switch leads. Operate switch and install new switch if test lamp does not go on and off.

(4) Touch test probes to each terminal and to ground. Install new terminal assembly or frame and field if ground is present (par. 145 **b** (2) and (4)).

(5) Inspect brush, switch and field coil leads for breaks and install new parts if breaks are found (par. 145 **b** (1)).

c. Gears, Driving Sector, and Wiper Shaft. Inspect gears for worn and damaged teeth. Discard parts if teeth are worn unevenly or excessively. Discard driving sector if crank arm is loose or binding.

d. Covers, Gaskets, and Screws. Discard covers if cracked or distorted. Discard gasket if broken. Discard screws if not in good condition.

145. REPAIR AND REBUILDING OF COMPONENTS.

a. Armature. Sand commutator with 2/0 flintpaper to remove minor burns and grooves. Blow off with clean, dry compressed air.

b. Base and Field.

(1) Unsolder defective switch leads and drive out switch rivets. Install new switch and rivet tightly. Solder leads to terminal and field coil using rosin core solder.

(2) Remove nuts holding terminal assembly and unsolder leads from defective terminal. Solder leads to new terminal with rosin core solder and install on frame and field.

(3) Press worn brushes out of holders and on pigtail type brushes unsolder brush lead. Press new brushes into holders and solder pigtails to terminals.

(4) Remove terminal assembly from defective frame and field and unsolder leads. Solder leads to new field coil and install terminal assembly.

146. ASSEMBLY (fig. 160).

a. Assemble Motor. Place frame and field in position and install four screws and lock washers. Apply thin coat of engine oil (SAE 10) to bearings and bearing seats. Install armature in motor. Install brush holders on pivots, keeping brush leads outside of arms in a position that will not interfere with movement. Inspect brush spring for correct assembly.

b. Install Gears and Shaft. Lubricate bearing surfaces with small amount of engine oil (SAE 10). Install thrust washer on worm gear stud. Install worm gear. Install crank gear with cam at bottom center. Place ¼ ounce No. 00 O.D. grease in gear chamber and spread over gears. Install driving sector. Turn armature until driving sector is in line with its pivot and center of wiper shaft bearing. Install wiper shaft with flat on shaft toward top of wiper. Install gear case cover and gasket, motor cover and their attaching screws. Install lock washer and nut on terminal stud, if pertinent. If wiper is to be mounted at bottom of windshield, grip wiper shaft and turn so that clutch releases and snaps back into place 180 degrees from its original position.

147. TESTS AND ADJUSTMENTS.

a. Refer to paragraph 141 c.

148. FITS, TOLERANCES, AND SPECIFICATIONS.

a. Refer to paragraph 140 b.

CHAPTER 6

GENERAL ELECTRICAL EQUIPMENT (Cont'd)

Section V

HORNS

149. DESCRIPTION AND DATA.

a. Description.

(1) HA- and HD-type horns are the vibrating diaphragm type. An armature is linked to the diaphragm and is operated by an electromagnet. When a voltage is applied to the electromagnet the armature is drawn toward the magnet. This movement flexes the diaphragm and also opens a set of contacts in the magnet circuit. As soon as the circuit is opened, the diaphragm forces the armature back to its original position which immediately closes the contacts and the cycle is repeated. The continuing cycles cause a constant vibration of the diaphragm and set up the sound waves.

(2) Do not clamp the horn flange in a vise as to do so may crack the diaphragm. Mount the horn by the mounting studs when testing or operating.

(3) For model numbers of horns, see paragraph 1.

b. Data.

HA type—rated 6 volts.

Set circuit breaker to draw 3.5 amperes at 5.5 volts.

Set striker screw to draw 4.5 amperes at 5.5 volts.

HD type—rated 12 volts.

Set circuit breaker to draw 2.6 amperes at 11.5 volts.

Set striker screw to draw 3.4 amperes at 11.5 volts. NOTE: *Set circuit breaker first with striker screw backed off to clear diaphragm.*

HORNS

150. CLEANING, INSPECTING, AND TESTING.

a. Cleaning. Wipe outside of horn with cloth dampened in dry-cleaning solvent. Clean inside of projector or front flange as far as possible without allowing dry-cleaning solvent to enter horn.

b. Inspecting. Inspect terminals and set screws for damaged or corroded threads. Inspect back projector and front flange for cracks. If these conditions are found overhaul horn and replace faulty parts (pars. 151 to 157). Tighten set screw lock nuts and flange screws. Overhaul horn if diaphragm and projector are caked with dirt (pars. 151 to 157).

c. Testing.

(1) With test probes test each terminal post for grounds. Overhaul horn if either post is grounded (pars. 151 to 157).

(2) Mount horn on test fixture. Connect battery, variable resistance, and ammeter, in series with two horn terminals. Connect voltmeter to two horn terminals. Close battery switch and adjust voltage to 5.5 volts for 6-volt horns or 11.5 volts for 12-volt horns. Read ammeter. Horn must have steady tone and current must be 4.5 amperes for 6-volt horns or 3.4 amperes for 12-volt horns. If horn does not operate at correct amperage loosen two set screw lock nuts and back off set screw at center of horn. Turn other set screw until current is 3.5 amperes at 5.5 volts for 6-volt horns or 2.6 amperes at 11.5 volts for 12-volt horns. Tighten lock nut and check current draw. Adjust center set screw to give current reading of 4.5 amperes at 5.5 volts for 6-volt horns or 3.4 amperes at 11.5 volts for 12-volt horns. Tighten lock nut. Overhaul horn if it does not have steady tone or if current cannot be adjusted (pars. 151 to 157).

151. DISASSEMBLY.

a. Note relation of mounting studs and drain hole to terminals.

b. Remove mounting studs and flange bolts. Lift off back assembly, diaphragm, two diaphragm gaskets, projector, or front flange.

152. CLEANING OF COMPONENTS.

a. Diaphragm and Projector or Flange. Soak in dry-cleaning solvent and clean and dry thoroughly.

b. Gaskets. Wipe clean with cloth dampened in dry-cleaning solvent.

c. Back Assembly. Blow off with clean dry air and wipe off with cloth dampened in dry-cleaning solvent. Dampen strip of linen tape in carbon tetrachloride and draw between contacts. Draw clean dry tape between contacts to remove any residue.

153. INSPECTION AND TEST OF COMPONENTS.

a. Diaphragm. Replace diaphragm if cracked, or if armature, ringer disk or stud is loose. Replace if diaphragm is corroded or rusted.

b. Gaskets. Replace diaphragm gaskets if torn or rough.

c. **Back Assembly.**

(1) Replace back assembly if contacts or coil are burned. Install new set screws or lock nuts if threads are stripped.

(2) Touch one test probe to ground on horn back and touch each terminal stud with other probe. If ground is present, disassemble terminal stud from back and test again. If still grounded replace back assembly. Install new terminal post insulation.

(3) Touch test probes to terminal studs. If lamp does not light replace back assembly.

d. **Projector or Front Flange.** Straighten if possible, otherwise replace cracked or dented projector or flange.

154. REPAIR AND REBUILDING OF COMPONENTS.

a. **Back Assembly.** Do not attempt to repair back if winding is grounded or shorted. Install new terminal stud insulation if necessary.

155. ASSEMBLY.

a. **Install Diaphragm and Projector.** Place one gasket in projector or front flange and line up holes. Install diaphragm and second gasket, and line up holes. Place back assembly on horn and turn so diaphragm lug will actuate contacts. Turn diaphragm and back so drain hole is in correct position. Install two flange bolts, lock washers, and nuts.

b. **Install Flange Bolts.** Install mounting studs in the holes noted before disassembly. Install balance of flange bolts, nuts, and lock washers. Tighten all six bolts equally and thoroughly.

156. TESTS AND ADJUSTMENTS.

a. Refer to paragraph 150 **c**.

157. FITS, TOLERANCES, AND SPECIFICATIONS.

a. Refer to paragraph 149 **b**.

CHAPTER 6

GENERAL ELECTRICAL EQUIPMENT (Cont'd)

Section VI

BOOSTER COILS

158. DESCRIPTION AND DATA.

a. Description.

(1) BC-4001 booster coil is an ignition spark coil used to supply the high voltage spark current during the starting period. It consists of a primary winding, a secondary winding, and a set of contacts. The contacts are connected in the primary circuit. When the coil is in operation current flows through the primary winding and through the contacts to ground. The magnetism of the primary winding immediately opens the contacts and breaks the primary circuit. Spring action closes the contacts. These cycles occur at high enough frequencies to induce a steady high tension voltage in the secondary winding. The high tension current is distributed to the spark plugs by the distributor cap and rotor. A condenser is connected across the contacts to protect the life of the contacts.

(2) Make, model, type, and part number, information is stamped on the name plate mounted on the bottom of the coil.

b. Data.

Rated Voltage—24

Condenser capacity—0.15 to 0.19 microfarads.

Current draw—0.6 to 0.75 amperes at 24.0 volts when firing three point 0.290-inch gap.

159. DISASSEMBLY.

a. Cleaning. Clean outside of case with cloth dampened in dry-cleaning solvent.

b. Disassembly. Slightly loosen lock nuts on primary and secondary terminals. Remove lock wire and take out four cover screws, lock washers, and plain washers. Lift off cover. Remove collars and seals from primary and secondary terminals. Pull tube and contac'

from secondary terminal. Slip terminal inserts out of case. Remove plug and ground nut, lock washer and plain washer from top of coil. Remove base and take insulating washer, plain washer and lock washer off ground stud.

160. CLEANING OF COMPONENTS.

a. **Base and Cover.** Soak in dry-cleaning solvent and clean and dry thoroughly. Clean paint and corrosion from ground contacts on both sides of ground stud hole and at inside bottom where contact strip grounds secondary winding.

b. **Coil and Contacts.** Wipe with cloth dampened in dry-cleaning solvent. File contacts with contact point dresser. File enough to smooth contacts but it is not necessary to remove every trace of burning. Clean contacts with linen tape dampened in carbon tetrachloride. Remove residue on contacts with clean dry linen tape. Be sure no lint is left on contacts. Clean ground contact at bottom of coil with 2/0 flintpaper.

c. **Terminal Seals and Contact Tube.** Wipe with cloth slightly dampened in dry-cleaning solvent.

d. **Terminal Inserts, Nuts, Washers, and Plug.** Soak in dry-cleaning solvent and clean thoroughly.

161. INSPECTION AND TEST OF COMPONENTS.

a. **Base and Cover.** Replace if cracked or if threads are stripped.

b. **Coil and Contacts.**

(1) Replace coil assembly if studs are loose or stripped or if contact at bottom is corroded, broken, or loose. Tighten nuts on contact spring and plate.

(2) Slip paper between contacts and measure condenser capacity from ground stud to contact spring stud. Replace coil if capacity is not between 0.15 and 0.19 microfarads. Remove paper from contacts. Be sure no lint from paper is left on contacts.

(3) Touch test probes to contact spring stud and primary terminal (single terminal separate from contacts). Replace coil assembly if primary winding is open.

(4) Inspect contacts. Install new contacts if burned or pitted (par. 162 a). Install new contact plate if thread is stripped or if contact screw lock is damaged.

c. **Miscellaneous Parts.** Replace secondary contact and tube if contact is loose or corroded or if tube is cracked. Replace terminal seals if worn or ragged. Install new nuts, inserts, washers, and plug, if not in serviceable condition.

162. REPAIR AND REBUILDING OF COMPONENTS.

a. **Coil and Contacts.** Remove adjustable contact screw and contact spring attaching nut and lock washer. Remove contact plate nuts and install new contact plate. Install new contacts and tighten nuts. Screw contact down until contacts just meet.

b. **Ground Contacts.** Sand surfaces of ground contacts with 2/0 flintpaper.

163. ASSEMBLY.

a. Install Base. Install nut, lock washer, and plain washer, on ground stud. Place base on coil. Install secondary terminal insert and contact tube. Tighten inside ground stud nut against base. Install insulating washer, plain washer, lock washer, and nut, on ground stud and tighten.

b. Install Cover. Install primary insert and thread test lead through insert. Connect lead to primary terminal (single stud separate from contacts). Install cover, cover screws, lock washers, plain washers, and tighten. Tighten terminal insert nuts.

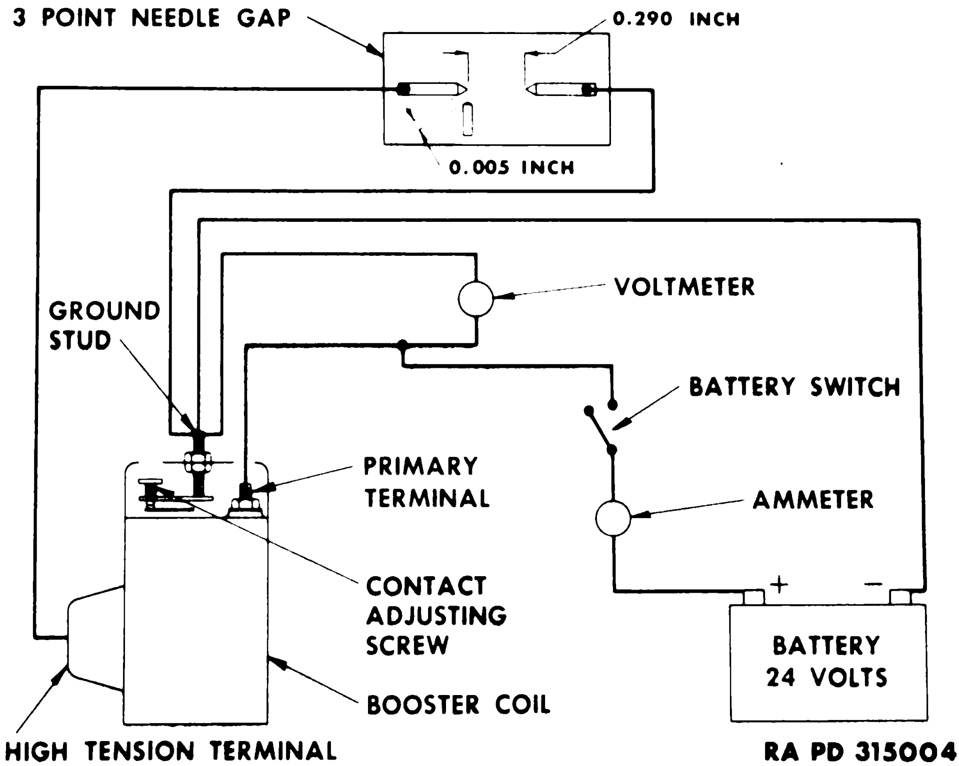


Figure 161—Booster Coil Test Hookup

164. TESTS AND ADJUSTMENTS.

a. Connections. Connect ammeter in series with fully charged 24-volt battery, ground stud and primary terminal. Connect a three point 0.290-inch spark gap between the high tension terminal and ground stud (fig. 161).

b. Test and Adjust. Close test stand battery switch. Insert screwdriver in hole in top of case and turn contact screw until ammeter shows a current of 0.6 to 0.75 amperes. Install new coil and contact assembly if current cannot be adjusted to 0.6 to 0.75 amperes at 24.0 volts or if a steady spark is not produced at 3 point gap. Open battery switch.

c. Disconnect Test Leads. Remove cover screws and disconnect lead from primary terminal. Disconnect other test leads. Install cover,

cover screws, lock washers, and plain washers. Tighten cover screws. Install terminal seals, collars, and cover plug.

165. FITS, TOLERANCES, AND SPECIFICATIONS.

Rated voltage—24.

Condenser capacity—0.15 to 0.19 microfarads.

Current draw—0.6 to 0.75 amperes at 24.0 volts when firing 0.290-inch three point gap.

CHAPTER 6

GENERAL ELECTRICAL EQUIPMENT (Cont'd)

Section VII

FILTERS AND SHIELDING

166. DESCRIPTION AND DATA.

a. Description.

(1) Filters and shielding are designed to reduce or eliminate radio interference due to the electrical system. Shielding consists of a grounded metal case mounted around current carrying conductors or units. This shielding restricts or confines the radio interference caused by electric currents. Filters are connected in electric circuits to block fluctuating peaks in the current due to the making and breaking of contacts in the ignition or charging system.

(2) Filters used in the high tension side of the ignition system consist of a high resistance unit with terminals for connecting to the wires, spark plugs, ignition coil, or distributor. Filters used in the ignition primary circuit and the charging circuit consist of a low resistance radio choke coil with condensers connected from each end of coil to ground. Do not substitute primary and charging circuit filters as incorrect filter resistance and capacity greatly affect the life of the ignition contacts and charging regulator.

(3) See paragraph 1 for model numbers of filters and shielding.

b. Data.

SP 1524—cable assembly—24½ inches long.

SP 1525—cable assembly—35 inches long.

SP 1547—distributor shield cover.

SP 1569—cable assembly—26½ inches long.

SP 2545—distributor shield—Left.

SP 2546—distributor shield—Right.

SP 2547—distributor shield cover and ignition leads.

SP 3545—distributor shield.

SP 4017—generator filter—Consists of condenser and choke coil and is connected between regulator and ammeter. Capacity 1.6 to 1.9 microfarads.

SP 4018—ignition coil and filter with shielding case. See CM 4001 ignition coil (pars. 120 and 121) and XA 643 filter (pars. 166 and 167).

XA 586—spark plug suppressor—consists of 10,000 to 15,000 ohm resistor.

XA 599—filter—consists of condenser and choke coil.

XA 600—filter—consists of condenser and choke coil.

XA 615—distributor high tension suppressor. Consists of 10,000 to 15,000 ohm resistor.

XA 636—condenser—0.4 to 0.6 microfarads.

XA 643—ignition primary filter—consists of condenser and choke coil. Capacity 1.5 to 2.0 microfarads. Resistance 0.014 to 0.020 ohms.

XA 665—spark plug suppressor—consists of 8,500 to 11,500 ohm resistor.

XA 671—generator filter—consists of condenser and choke coil inside shielding case.

XA 686—filter—consists of condenser and choke coil inside shielding case.

167. CLEANING, INSPECTING, AND TESTING.

a. Cleaning. Clean thoroughly with cloth dampened in dry-cleaning solvent. Do not soak non-metal parts in dry-cleaning solvent.

b. Inspecting. Inspect for loose terminals, loose connections, and frayed insulation. Replace faulty parts or units. Replace shielding if it cannot be straightened to give satisfactory service. Inspect for corroded or burned terminals and connections and replace if such conditions are found.

c. Testing. Test leads and filters for grounds and opens with direct current test probes. Do not use alternating current test probes as most filters will test grounded if alternating current is used. Replace if grounded or open. Measure condenser capacity of filters that include condensers. Measure capacity from either terminal to case and replace filter if capacity is not as specified (par. 166 **b**).

CHAPTER 6

GENERAL ELECTRICAL EQUIPMENT (Cont'd)

Section VIII

SPECIAL SOLENOIDS

168. DESCRIPTION AND DATA.

a. Description.

(1) SS, SSK, and SSL type switches close an electric circuit when the control circuit is closed. They are used to allow a small capacity push button or switch to remotely control a larger current for starting, ignition or other load. A switch blade is mounted on the solenoid plunger. This blade contacts two terminals when the solenoid is energized and completes the load circuit.

(2) SSH, WS, WSA, WSC, and WSF type solenoids have their plunger linked to a gun firing mechanism and operate the gun whenever the solenoid winding is energized.

(3) For model numbers of special solenoids, see paragraph 1.

b. Data.

Solenoid	Type Duty	Rated Volts	Control Circuit	Current Draw Volts	Current Draw Amps	Closing Voltage	Opening Voltage
SS 4506	Intermittent	24	2—10-32 terms.	12	1.5–1.7	12.5–15.5	1.5–2.0
SSH 4001	Gun firing	12	10–32 term. to grd	See note 1		....	....
SSK 4001	Continuous	12	10–32 term. to grd	12	0.65–0.72	8.5 max	2.5 max
SSL 4001	Continuous	24	10–32 term. to grd	24	0.35–0.39	17.0 max	5.0 max
SSL 4002	Continuous	24	10–32 term. to grd	24	0.35–0.39	17.0 max	5.0 max
SSL 4002A	Continuous	24	10–32 term to bat term	24	0.35–0.39	17.0 max	5.0 max
WS 4001	Gun firing	24	2—10–32 terms.	See note 2		....	....
WS 4002	Gun firing	24	2—10–32 terms.	See note 3		....	....
WSA 4001	Gun firing	24	2—10–32 terms.	See note 4		....	....
WSA 4001A	Gun firing	24	2—10–32 terms.	See note 4		....	....
WSC 4001	Fuel cut-off	24	2—10–32 terms.	See note 5		....	....
WSF 4001	Fuel cut-off	12	10–32 term to grd	See note 6		....	....

Note 1—Current draw—Holding coil only—1.10 to 1.30 amperes at 12.0 volts. Both coils—43 to 49 amperes at 12.0 volts. Pull on core to be not less than 25 pounds with plunger $\frac{3}{8}$ inch from bottom. Coil must hold in 30 pounds at 12.0 volts.

Note 2—With 20-pound load, plunger must bottom at 5.0 amperes maximum current. Travel $\frac{11}{32}$ in.

Note 3—With 20-pound load, plunger must bottom at 5.5 amperes maximum current. Travel $\frac{13}{32}$ in.

Note 4—With 20-pound load, plunger must bottom at 5.2 amperes maximum current. Travel $\frac{11}{32}$ in.

Note 5—With 20-pound load, plunger must bottom at 7.0 amperes maximum current. Travel $\frac{13}{32}$ in.

Note 6—With 15-pound load, plunger must bottom at 20 amperes maximum current. Travel $\frac{13}{32}$ in.

SPECIAL SOLENOIDS

169. CLEANING, INSPECTING, AND TESTING.

a. Cleaning.

(1) Wipe outside of solenoid with cloth dampened in cleaning solvent.

(2) Remove cover screws and take off covers. Remove linkage. Remove plunger nut and take out plunger.

(3) Clean covers, linkage, plunger and other metal parts in dry-cleaning solvent. Blow off solenoid with clean dry compressed air.

b. Inspecting.

(1) Inspect core and plunger for roughness and corrosion and discard if not perfectly smooth. Solder or tighten loose connections. Inspect linkage for wear and discard if pivots are worn.

(2) On solenoids with both terminals insulated, check for grounds with test probes. Discard solenoid if grounded. Check control circuit for opens by touching test probes to two ends of circuit (par. 168 **b**). Discard solenoid if open.

(3) Inspect case, bracket and covers for cracks and dents and discard if damaged.

(4) Inspect contacts on SSH 4001. Discard solenoid if contacts are burned or corroded.

c. Testing.

(1) Apply a light film of engine oil (SAE 10) to core and install core in solenoid. Install core nut and adjust position of nut to give correct core travel (par. 168 **b**).

(2) Connect ammeter, battery of rated voltage and variable resistance in series with solenoid control circuit (par. 168 **b**). Mount solenoid and arrange plunger of gun firing types to lift correct load. On SS, SSK and SSL types connect voltmeter across control circuit. Close battery switch and decrease resistance slowly. Note voltage and current when solenoid operates. Increase resistance and note opening voltage. If closing and opening figures are not within specifications, check plunger travel on gun firing types and replace solenoid if this does not bring operation within limits.

(3) On SS, SSK, and SSL types connect carbon pile rheostat, 200 ampere ammeter and battery of rated voltage in series with two large terminals. Connect voltmeter to two large terminals and connect control circuit to battery. Adjust carbon pile to give 100 amperes current and read voltmeter. If voltage drop is more than 0.40 volts replace solenoid.

(4) Install covers and linkage and lubricate linkage pivots sparingly with engine oil (SAE 30). Operate linkage and repair binding so that linkage operates freely.

CHAPTER 7

SPECIFICATIONS

Section I

GENERATORS

170. GENERATOR SPECIFICATIONS.

a. **Data.**

Generator	Group	Paragraph	Volts	Rotation	Brush Tension Ounces	Control	Field Draw at 6.0 V.	Motor Draw at 6.0 V.	Volts	Output Amps.	Max RPM
GAS 4151	1	5–13	6	CW	15–20	CO	4.1–4.5	5.3–5.9	8.0	7.1	.....
GAS 4166	1	5–13	6	CCW	15–20	CO	4.1–4.5	5.3–5.9	8.0	7.1	.....
GAS 4172	1	5–13	6	CCW	15–20	CO	4.1–4.5	5.3–5.9	8.0	7.1	.....
GBG 4601	3	23–31	12	CW	23–26	CVR	1.4–1.5*	4.0–4.4*	15.0	40.0	1,150
GBG 4612	3	23–31	12	CCW	23–26	CVR	1.4–1.5*	4.0–4.4*	15.0	40.0	1,150
GDE 4107	1	5–13	6	CCW	15–20	TC	4.1–4.5	5.5–6.1	8.0	18.0	.....
GDE 4108	1	5–13	6	CCW	15–20	TC	4.1–4.5	5.5–6.1	8.0	18.0	.....
GDJ 4802A	3	23–31	12	CW	71–76	CVR	1.5–1.7*	7.6–8.4*	15.0	55.0	1,200
GDJ 4804, A, B, C	3	23–31	12	CW	71–76	CVR	1.5–1.7*	7.6–8.4*	15.0	55.0	1,200
GDJ 4008, A	3	23–31	12	CW	71–76	CVR	1.5–1.7*	7.6–8.4*	15.0	55.0	1,200
GDJ 4809A, B	3	23–31	12	CW	71–76	CVR	1.5–1.7*	7.6–8.4*	15.0	55.0	1,200
GDJ 4812A	3	23–31	12	CW	71–76	CVR	1.5–1.7*	7.6–8.4*	15.0	55.0	1,200
GDJ 4819A	3	23–31	12	CW	71–76	CVR	1.5–1.7*	7.6–8.4*	15.0	55.0	1,200
GDJ 4820A	3	23–31	12	CW	71–76	CVR	1.5–1.7*	7.6–8.4*	15.0	55.0	1,200
GDM 4803	2	14–22	12	CW	30–37	CVR	1.5–1.7*	3.3–3.7*	15.0	30.0	1,500

GENERATORS

Generator	Group	Paragraph	Volts	Rotation	Brush Tension Ounces	Control	Field Draw at 6.0 V.	Motor Draw at 6.0 V.	Volts	Output Amps.	Max RPM
GDM 5001	2	14–22	12	CW	30–37	CVR	1.5–1.7*	3.3–3.7*	15.0	35.0	1,700
GDZ 4801, A, B, C, D	2	14–22	6	CW	53 max	CVR	1.6–1.8	4.1–4.6	8.0	35.0	1,900
GEA 4802A	2	14–22	6	CW	53 max	CVR	1.6–1.8	4.4–4.9	8.0	35.0	1,800
GEB 4810	2	14–22	6	CW	64–68	CVR	1.6–1.8	4.0–4.5	8.0	32.0	1,250
GEG 5001A	2	14–22	6	CW	64–68	CVR	1.6–1.8	4.7–5.2	8.0	40.0	1,550
GEG 5002, A, B, C, D, E, F	2	14–22	6	CW	64–68	CVR	1.6–1.8	4.7–5.2	8.0	40.0	1,550
GEG 5004A	2	14–22	6	CW	64–68	CVR	1.6–1.8	4.7–5.2	8.0	40.0	1,550
GEH 4806	2	14–22	12	CW	64–68	CVR	1.4–1.6*	3.3–3.7*	15.0	17.0	1,225
GEH 5002	2	14–22	12	CCW	64–68	CVR	1.4–1.6*	3.3–3.7*	15.0	26.0	1,500
GEW 4802	2	14–22	6	CW	64–68	CVR	1.6–1.8	3.2–3.6	8.0	25.0	1,050
GEW 4803, A	2	14–22	6	CW	64–68	CVR	1.6–1.8	3.2–3.6	8.0	25.0	1,050
GEW 4804	2	14–22	6	CW	64–68	CVR	1.6–1.8	3.2–3.6	8.0	25.0	1,050
GEW 4805	2	14–22	6	CCW	64–68	CVR	1.6–1.8	3.2–3.6	8.0	25.0	1,050
GEW 4806, A, B, C	2	14–22	6	CW	64–68	CVR	1.6–1.8	3.2–3.6	8.0	25.0	1,050
GFK 4801	2	14–22	12	CCW	30–37	CVR	1.5–1.7*	3.3–3.7*	15.0	30.0	1,500
GFM 4801, A	2	14–22	12	CW	30–37	CVR	1.4–1.6*	6.1–6.7*	15.0	50.0	1,900
GFR 4801, A, B	4	32–40	24	CCW	71–76	CVR	0.9–1.0†	5.2–5.7†	30.0	50.0	1,725
GFR 4802, A, B	4	32–40	24	CCW	71–76	CVR	0.9–1.0†	5.2–5.7†	30.0	50.0	1,725
GFR 4803, A, B	4	32–40	24	CCW	71–76	CVR	0.9–1.0†	5.2–5.7†	30.0	50.0	1,725
GFR 4804A, B, C	4	32–40	24	CCW	71–76	CVR	0.9–1.0†	5.2–5.7†	30.0	50.0	1,725
GFZ 4801, A, B	3	23–31	24	CW	71–76	CVR	0.9–1.0†	2.9–3.2†	30.0	25.0	950
GGA 4801A	2	14–22	12	CW	30–37	CVR	1.5–1.6*	2.9–3.2*	15.0	40.0	1,600

*—At 13.0 volts.
†—At 26.0 volts.
CO—Third brush control (uses cut-out relay only).
CCW—Counterclockwise rotation at drive end.

CVR—Shunt type (uses separately mounted current and voltage regulator).
CW—Clockwise rotation at drive end.
TC—Third brush and two charge regulator control.
For further information refer to paragraphs tabulated.

CHAPTER 7—Section II

REGULATORS

171. REGULATOR SPECIFICATIONS.

a. Data.

Regulator	Group	Paragraph	Rated Voltage	Ground Polarity	Circuit Breaker: Closing Volts	Circuit Breaker: Opening Volts	Circuit Breaker: Opening Amps	Current Regulator Operating Amps	Voltage Regulator Operates	Internal Wiring
CB 4014	1	43–47	6	Neg	6.5–7.25	....	0.5–2.5	....	..	Fig. 80
TC 4328A	2	43–47	6	Neg	6.5–7.25	....	0.5–2.5	....	G	Fig. 80
VAC 4001A	4	53–61	12	Pos	13.0–13.5	....	0.5–6.0	29.0–31.0	A	Fig. 97
VAD 4103A	4	53–61	24	Neg	25.7–26.7	....	16.0–21.0	50.0–53.0	B	Fig. 98
VAD 4105A	4	53–61	24	Neg	25.7–26.7	....	16.0–21.0	50.0–53.0	B	Fig. 98
VAD 4106A	4	53–61	24	Neg	25.7–26.7	....	16.0–21.0	50.0–53.0	B	Fig. 98
VAD 4106B	4	53–61	24	Neg	25.7–26.7	....	16.0–21.0	50.0–53.0	B	Fig. 98
VAL 4101A	4	53–61	24	Neg	26.0–27.2	....	3.0–5.0	25.0–27.0	C	Fig. 97
VAM 4101A	4	53–61	12	Neg	13.0–13.5	....	0.5–6.0	39.0–41.0	A	Fig. 99
VRA 4102A	4	53–61	12	Pos	13.0–13.5	....	0.5–6.0	39.0–41.0	A	Fig. 97
VRA 4105A	4	53–61	12	Neg	13.0–13.5	....	0.5–6.0	39.0–41.0	A	Fig. 97
VRG 4102B	4	53–61	12	Pos	13.0–13.5	....	0.5–6.0	25.0–27.0	A	Fig. 97
VRG 4103C	4	53–61	12	Neg	13.0–13.5	....	0.5–6.0	34.0–36.0	A	Fig. 97
VRH 4101C	4	53–61	12	Pos or Neg	13.0–13.5	....	0.5–6.0	49.0–51.0	A	Fig. 99
VRH 4102A	4	53–61	12	Pos or Neg	13.0–13.5	....	0.5–6.0	54.0–56.0	A	Fig. 99
VRH 4104A-1	4	53–61	12	Pos or Neg	13.0–13.5	....	0.5–6.0	54.0–56.0	A	Fig. 99
VRH 4104B-1	4	53–61	12	Pos or Neg	13.0–13.5	....	0.5–6.0	54.0–56.0	D	Fig. 99
VRH 4104C-1	4	53–61	12	Pos or Neg	13.0–13.5	....	0.5–6.0	54.0–56.0	A	Fig. 99
VRH 4105A	4	53–61	12	Pos or Neg	13.0–13.5	....	0.5–6.0	49.0–51.0	A	Fig. 99
VRH 4106A	4	53–61	12	Pos or Neg	13.0–13.5	....	0.5–6.0	54.0–56.0	A	Fig. 99

Regulator	Group	Paragraph	Rated Voltage	Ground Polarity	CIRCUIT BREAKER Closing Volts	CIRCUIT BREAKER Opening Volts	CIRCUIT BREAKER Opening Amps	Current Regulator Operating Amps	Voltage Regulator Operates	Internal Wiring
VRP 4001A	3	48–52	6	Pos	6.4–7.0†	4.1–4.8	....	34.0–36.0	E	Fig. 84
VRP 4002C	3	48–52	6	Pos	6.4–7.0†	4.1–4.8	....	34.0–36.0	E	Fig. 84
VRP 4004G	3	48–52	6	Pos	6.4–7.0†	4.1–4.8	....	24.0–26.0	E	Fig. 84
VRP 4006E	3	48–52	6	Pos	6.4–7.0†	4.1–4.8	....	31.0–33.0	E	Fig. 84
VRS 4004B	3	48–52	12	Pos	13.0–13.7	8.2–9.3	....	16.0–18.0	F	Fig. 84
VRX 4001A	3	48–52	12	Pos	13.0–13.7	8.2–9.3	....	29.0–31.0	F	Fig. 84
VRY 4201A	4	53–61	6	Pos	6.5–7.0†	....	0.5–6.0	25.0–27.0	E	Fig. 100
VRY 4201B	4	53–61	6	Pos	6.5–7.0†	....	0.5–6.0	32.0–34.0	E	Fig. 100
VRY 4203A	4	53–61	6	Neg	6.5–7.0†	....	0.5–6.0	40.0–42.0	E	Fig. 100
VRY 4203B	4	53–61	6	Neg	6.5–7.0†	....	0.5–6.0	40.0–42.0	E	Fig. 100

Neg—Negative ground polarity.
Pos—Positive ground polarity.

Operating Voltages Temperature F	50°	60°	70°	80°	90°	100°	110°	120°	Tolerance
Test A	14.31	14.28	14.25	14.22	14.19	14.16	14.13	14.10	±0.25
Test B	28.58	28.54	28.50	28.46	28.41	28.37	28.33	28.29	±0.40
Test C	29.38	29.34	29.30	29.26	29.21	29.17	29.13	29.09	±0.40
Test D	14.56	14.53	14.50	14.47	14.44	14.41	14.38	14.35	±0.25
Test E	7.41	7.38	7.35	7.32	7.29	7.26	7.23	7.20	±0.15
Test F	14.58	14.54	14.50	14.46	14.42	14.38	14.34	14.30	±0.30
Test G*	8.65	8.57	8.50	8.43	8.35	8.28	8.21	8.14	±0.25

* This is contact opening voltage—closing voltage is 1.2 to 1.4 volts below the reading obtained for the opening voltage.

† When adjusting set closing voltage at 6.4 to 6.6 volts.

CHAPTER 7—Section III
DISTRIBUTORS

172. DISTRIBUTOR SPECIFICATIONS.

a. Data.

Distributor	Group	Paragraph	Rotation	Cylinders	Condenser Capacity Mfd	Contact Gap Inches	Cam Dwell	Manual Advance	GOVERNOR Advance	GOVERNOR Curve	VACUUM Advance	VACUUM Curve
IAC 4001	2	73–81	L.H.	6	0.20–0.24	0.020	38°	...	12°	419	....	...
IAC 4002	2	73–81	L.H.	6	0.20–0.24	0.020	38°	...	12°	419	....	...
IAC 4002A	2	73–81	L.H.	6	0.20–0.24	0.020	38°	...	12°	845	....	...
IAC 4003	2	73–81	R.H.	6	0.20–0.24	0.020	38°	...	10°	191	....	...
IGC 4054D	1	64–72	L.H.	6	0.20–0.25	0.020	40°	10°	12°	730	....	...
IGC 4281	1	64–72	R.H.	6	0.20–0.25	0.020	40°	...	6°	605	....	...
IGC 4286	1	64–72	R.H.	6	0.20–0.25	0.020	40°	6°	6°	368	....	...
IGC 4701	1	64–72	R.H.	6	0.18–0.26	0.020	38°	6°	6°	368	....	...
IGC 4701-1	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	6°	368	....	...
IGC 4701-2	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	6°	368	....	...
IGC 4702A	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	9°	756●	....	...
IGC 4703,-1	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	10°	770	....	...
IGC 4704,-1	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	10°	770	....	...
IGC 4705	1	64–72	L.H.	4	0.18–0.26	0.020	42°	...	11°	789	....	...
IGC 4706A	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	11°	803	....	...
IGC 4707,-1	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	10°	770	....	...
ICG 4708	1	64–72	R.H.	6	0.18–0.26	0.020	38°	6°	10°	191	....	...
IGC 4709A	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	9°	756	....	...
IGC 4710-2	1	64–72	L.H.	6	0.18–0.26	0.020	38°	...	16°	414	....	...
IGC 4716	1	64–72	L.H.	6	0.18–0.26	0.020	38°	10°	12°	730	....	...
IGC 4717,-1	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	11°	774	....	...
IGC 4902A	1	64–72	R.H.	6	0.18–0.26	0.020	38°	...	7°	378	....	...
IGE 4003H	1	64–72	L.H.	6	0.20–0.25*	0.020	35°	10°	12.5°	676	....	...
IGE 4003H-1	1	64–72	L.H.	6	0.20–0.25*	0.020	35°	10°	12.5°	676	....	...
IGE 4029	1	64–72	R.H.	6	0.20–0.25*	0.020	35°	...	9°	829	....	...
IGS 4111,-1	1	64–72	R.H.	6	0.25–0.28	0.020	38°	...	11°	480	10°	620
IGS 4112,-1	1	64–72	R.H.	6	0.25–0.28	0.020	38°	...	12°	478	8°	584
IGS 4114,-1	1	64–72	R.H.	6	0.25–0.28	0.020	38°	...	12°	478	8°	584
IGS 4202A,-1	1	64–72	R.H.	6	0.25–0.28	0.020	38°	...	11°	774	6°	527
IGS 4203B,-1	1	64–72	R.H.	6	0.25–0.28	0.020	38°	...	10°	770	8.5°	767

Distributor	Group	Paragraph	Rotation	Cylinders	Condenser Capacity Mfd	Contact Gap Inches	Cam Dwell	Manual Advance	GOVERNOR Advance	GOVERNOR Curve	VACUUM Advance	VACUUM Curve
IGS 4204,-1	1	64–72	R.H.	6	0.25–0.28	0.020	38°	...	11°	480	10°	620
IGT 4102	1	64–72	L.H.	8	0.20–0.25	0.017	27°	...	11.5°	654	5.5°	550
IGW 4049	3	82–90	R.H.	2	0.20–0.25	0.020	111°	18°	.....	...	....	...
IGW 4053	3	82–90	R.H.	2	0.20–0.25	0.020	111°	18°	.....	...	....	...
IGW 4147	3	82–90	R.H.	6	0.20–0.25	0.020	35°	6°	10°	191	....	...
IGW 4154	3	82–90	L.H.	6	0.20–0.25	0.020	35°	...	7°	378	....	...
IGW 4165A	3	82–90	R.H.	2	0.20–0.25	0.020	....	...	15°	782	....	...
IGW 4165B	3	82–90	R.H.	2	0.20–0.25	0.020	....	...	15°	802	....	...

Contact pressure for all distributors—17 to 20 ounces.
L.H.—Left-hand rotation when viewed from top.
R.H.—Right-hand rotation when viewed from top.
*Two condensers of this capacity are used.

b. Governor Advance Curves.

Advance Curve	0° Advance RPM	1° Advance RPM	Intermediate Advance	Intermediate RPM	Maximum Less 1° Advance	Maximum Less 1° RPM	Maximum Advance	Maximum RPM
191	300	410	5°	850	9°	1,290	10°	1,400
368	275	375	3°	580	5°	790	6°	900
378	400	540	3°	830	6°	1,260	7°	1,400
414	250	280	7°	450	15°	1,340	16°	1,450
419	350	370	3°	400	11°	1,400	12°	1,530
478	350	367	3°	400	11°	1,600	12°	1,750
480	350	367	3°	400	10°	1,670	11°	1,850
605	300	440	3°	725	5°	1,010	6°	1,150
654	250	325	6°	700	10°	1,500	11.5°	1,800
676	250	290	6°	490	11°	690	12.5°	750
730	250	280	9°	500	11°	970	12°	1,200
756	275	380	4°	680	8°	1,100	9°	1,200
770	350	367	3°	400	9°	1,050	10°	1,150
774	350	367	3°	400	10°	1,275	11°	1,400
782	300	330	7°	510	14°	720	15°	750
789	250	360	5°	820	10°	1,380	11°	1,500
802	300	340	7°	600	14°	880	15°	925
803	300	370	5°	650	10°	1,770	11°	2,000
829	300	350	4°	480	8°	660	9°	700
845	425	450	4°	525	11°	1,400	12°	1,525
Tolerance	±50	±50	±1°	...	±1°	....	±1°	....

All figures in distributor degrees and RPM.

c. Vacuum Advance Curves.

Advance Curve	0° Advance Inches of Hg	1° Advance Inches of Hg	Intermediate Advance	Intermediate In. (Hg)	Maximum Less 1° Advance	Maximum Less 1° In. (Hg)	Maximum Advance	Maximum In. (Hg)
527	5⅛	6⅝	3°	9⅝	5°	12½	6°	14
550	7	8⅝	3°	12	4°	13½	5.5°	16
584	5	6⅜	4°	10½	7°	14⅝	8°	16
620	5	6¼	5°	11	9°	15¾	10°	17
767	5	6¼	4°	10⅛	7°	14	8.5°	16
Tolerance	±1	±1	..	±1	±1°	....	±1°	..

All figures are in distributor degrees and inches of mercury (Hg).

CHAPTER 7—Section IV

CRANKING MOTORS

173. CRANKING MOTOR SPECIFICATIONS.

a. Data.

Motor	Group	Paragraphs	Rated Volts	Rotation	Type of Clutch	No-Load Volts	No-Load Max Amps	No-Load Min RPM	Stall Torque Volts	Stall Torque Max RPM	Stall Torque Min Ft Lbs	Internal Wiring
MAB 4071	1	93–101	6	CW	Bendix	5.5	60	3,700	3.0	582	15.8	Fig. 135
MAB 4082	1	93–101	6	CW	Bendix	5.5	60	3,700	3.0	582	15.8	Fig. 135
MAS 4003	2	102–110	12	CW	Bendix	11.0	42	4,100	6.0	440	20.0	Fig. 143
MAS 4009	2	102–110	12	CW	Bendix	11.0	42	4,100	6.0	440	20.0	Fig. 143
MAU 4006	1	93–101	12	CW	Bendix	11.0	65	4,800	6.0	540	17.3	Fig. 135
MAW 4029	1	93–101	6	CW	Overrunning	5.5	65	4,900	3.0	505	11.5	Fig. 135
MAX 4041	1	93–101	6	CW	Overrunning	5.5	77	2,695	3.0	652	33.5	Fig. 135
MAY 4114A, B	1	93–101	12	CW	Overrunning	11.0	30	5,300	6.0	285	13.2	Fig. 135
MAY 4132	1	93–101	12	CW	Overrunning	11.0	30	5,300	6.0	285	13.2	Fig. 135
MAY 4133	1	93–101	12	CW	Overrunning	11.0	30	5,300	6.0	285	13.2	Fig. 135
MAY 4137	1	93–101	12	CW	Bendix	11.0	30	5,300	6.0	285	13.2	Fig. 135
MAY 4138	1	93–101	12	CW	Bendix	11.0	30	5,300	6.0	285	13.2	Fig. 135
MAY 4141	1	93–101	12	CW	Overrunning	11.0	30	5,300	6.0	285	13.2	Fig. 135
MBD 4007, A, B	3	111–119	24	CW	Bendix	20.0	70	1,480	4.0	400	74	Fig. 152
MBD 4008	3	111–119	24	CW	Bendix	20.0	65	5,300	4.0	380	21	Fig. 152
MBD 4010, A	3	111–119	24	CW	Bendix	20.0	70	1,480	4.0	400	74	Fig. 152
MBY 4001	1	93–101	24	CW	Bendix	20.0	20	4,200	12.0	180	15.0	Fig. 135
ML 4209	2	102–110	12	CW	Bendix	5.5	60	2,980	3.0	555	18.0	Fig. 143
ML 4211	2	102–110	6	CW	Bendix	5.5	60	2,980	3.0	555	18.0	Fig. 143
MR 4104	2	102–110	6	CW	Bendix	5.5	50	2,800	3.0	525	30.0	Fig. 143
MZ 4059, A	1	93–101	6	CW	Overrunning	5.5	70	4,300	3.0	420	7.8	Fig. 135
MZ 4089A	1	93–101	6	CW	Overrunning	5.5	70	4,300	3.0	420	7.8	Fig. 135
MZ 4113	1	93–101	6	CW	Bendix	5.5	70	4,300	3.0	420	7.8	Fig. 135
MZ 4115	1	93–101	6	CW	Overrunning	5.5	70	4,300	3.0	420	7.8	Fig. 135

Bendix—Bendix type automatic clutch. CW—Clockwise rotation at the drive end. Overrunning—Overrunning clutch.

CHAPTER 7—Section V

GENERAL EQUIPMENT

174. SPECIFICATIONS OF GENERAL EQUIPMENT.

a. Data.

Unit		Group	Paragraph	Rated Volts	Type Duty
BC	4001	...	158–165	24	Booster coil
CE	4645	...	120–121	6	Lock-type ignition coil
CE	4654	...	120–121	6	Lock-type ignition coil
CF	4001	...	120–121	12	Ignition coil
CF	4003	...	120–121	12	Ignition coil
CF	4009	...	120–121	12	Ignition coil
CF	4013A	...	120–121	12	Ignition coil
CM	4001	...	120–121	12	Ignition coil
CM	4002	...	120–121	12	Ignition coil
CM	4006	...	120–121	12	Ignition coil
CM	4007	...	120–121	12	Ignition coil
CM	4010	...	120–121	12	Ignition coil
CM	4012	...	120–121	12	Ignition coil
CM	4013	...	120–121	12	Ignition coil
CO	4001	...	120–128	24	Tank ignition coil
CO	4002	...	120–128	24	Tank ignition coil
CP	4001	...	120–128	12	Tank ignition coil
HA	4001	...	149–157	6	Horn
HA	4032	...	149–157	6	Horn
HA	4032A	...	149–157	6	Horn
HD	4001	...	149–157	12	Horn
HD	4017	...	149–157	12	Horn
HD	4017A	...	149–157	12	Horn
IG	4065	...	120–121	6	Ignition coil
IG	4070H	...	120–121	6	Ignition coil
IG	4070J	...	120–121	6	Ignition coil
IG	4070L	...	120–121	6	Ignition coil
IG	4070P	...	120–121	6	Ignition coil
IG	4070Q	...	120–121	6	Ignition coil
IG	4092	...	120–121	6	Ignition coil
IG	4652	...	120–121	6	Lock-type ignition coil
IG	4661	...	120–121	6	Lock-type ignition coil
IG	4801	...	120–121	6	Ignition coil
SP	1524	...	166–167	..	Shielded cable
SP	1525	...	166–167	..	Shielded cable
SP	1547	...	166–167	..	Distributor shield cover
SP	1569	...	166–167	..	Shielded cable
SP	2545	...	166–167	..	Distributor shield—left
SP	2546	...	166–167	..	Distributor shield—right
SP	2547	...	166–167	..	Distributor shield cover with leads
SP	3545	...	166–167	..	Distributor shield
SP	4017	...	166–167	..	Generator filter
SP	4018	...	166–167	..	Ignition coil and filter
		...	120–121	..	Includes CM 4001 Ignition coil
		...	166–167	..	XA 643 Filter
SP	4022	...	....	12	Generator kit
		3	23–31	12	Includes GDJ 4804B Generator
		4	53–61	12	VRH 4104B-1 Regulator
SP	4022B	...	....	12	Generator kit
		3	23–31	12	Includes GDJ 4803C Generator
		4	53–61	12	VRH 4104B-1 Regulator

Unit	Group	Paragraph	Rated Volts	Type Duty
SP 4027	...	....	24	Generator kit
	3	23–31	24	Includes GFZ 4801A Generator
	4	53–61	24	VAL 4101A Regulator
SP 4027B	...	....	24	Generator kit
	3	23–31	24	Includes GFZ 4801B Generator
	4	53–61	24	VAL 4101A Regulator
SS 4001	2	131–132	6	Starter solenoid switch
SS 4022	2	131–132	12	Starter solenoid switch
SS 4205	2	131–139	6	Starter solenoid switch
SS 4209	2	131–139	12	Starter solenoid switch
SS 4209A	2	131–139	12	Starter solenoid switch
SS 4210	2	131–139	12	Starter solenoid switch
SS 4505	2	131–132	24	Starter solenoid switch
SS 4506	...	168–169	24	Solenoid switch
SSH 4001	...	168–169	12	Gun firing solenoid
SSK 4001	...	168–169	12	Solenoid switch
SSL 4001	...	168–169	24	Solenoid switch
SSL 4002	...	168–169	24	Solenoid switch
SSL 4002A	...	168–169	24	Solenoid switch
SW 2677A	1	129–130	..	Manual starting switch
SW 2813	1	129–130	..	Manual starting switch
SW 4001	1	129–130	..	Manual starting switch
SW 4002	1	129–130	..	Manual starting switch
SW 4011	1	129–130	..	Manual starting switch
SW 4013	1	129–130	..	Manual starting switch
SW 4015	1	129–130	..	Manual starting switch
WS 4001	...	168–169	24	Gun firing solenoid
WS 4002	...	168–169	24	Gun firing solenoid
WSA 4001	...	168–169	24	Gun firing solenoid
WSA 4001A	...	168–169	24	Gun firing solenoid
WSC 4001	...	168–169	24	Fuel cut-off solenoid
WSE 4001	2	131–139	24	Starter solenoid switch
WSE 4001A	2	131–139	24	Starter solenoix switch
WSE 4002	2	131–139	24	Starter solenoid switch
WSE 4003	2	131–139	24	Starter solenoid switch
WSF 4001	...	168–169	12	Fuel cut-off solenoid
XA 456	1	129–130	..	Starter push button
XA 532	1	129–130	..	Starter push button
XA 570	1	129–130	..	Starter series parallel switch
XA 572	1	129–130	..	Starter push button
XA 586	...	166–167	..	Suppressor
XA 599	...	166–167	..	Filter
XA 600	...	166–167	..	Filter
XA 615	...	166–167	..	Suppressor
XA 636	...	166–167	..	Condenser
XA 643	...	166–167	..	Filter
XA 665	...	166–167	..	Suppressor
XA 671	...	166–167	..	Filter
XA 686	...	166–167	..	Filter
28474	...	140–148	6	Windshield wiper
28533	...	140–148	12	Windshield wiper
28938	...	140–148	12	Windshield wiper
28942	...	140–148	6	Windshield wiper
29059	...	140–148	6	Windshield wiper
29078	...	140–148	6	Windshield wiper
29118	...	140–148	12	Windshield wiper
29150	...	140–148	6	Windshield wiper
29180	...	140–148	6	Windshield wiper
29192	...	140–148	6	Windshield wiper
29308	...	140–148	12	Windshield wiper
29366	...	140–148	6	Windshield wiper

CHAPTER 8

SPECIAL TOOLS

175. SPECIAL TOOLS.

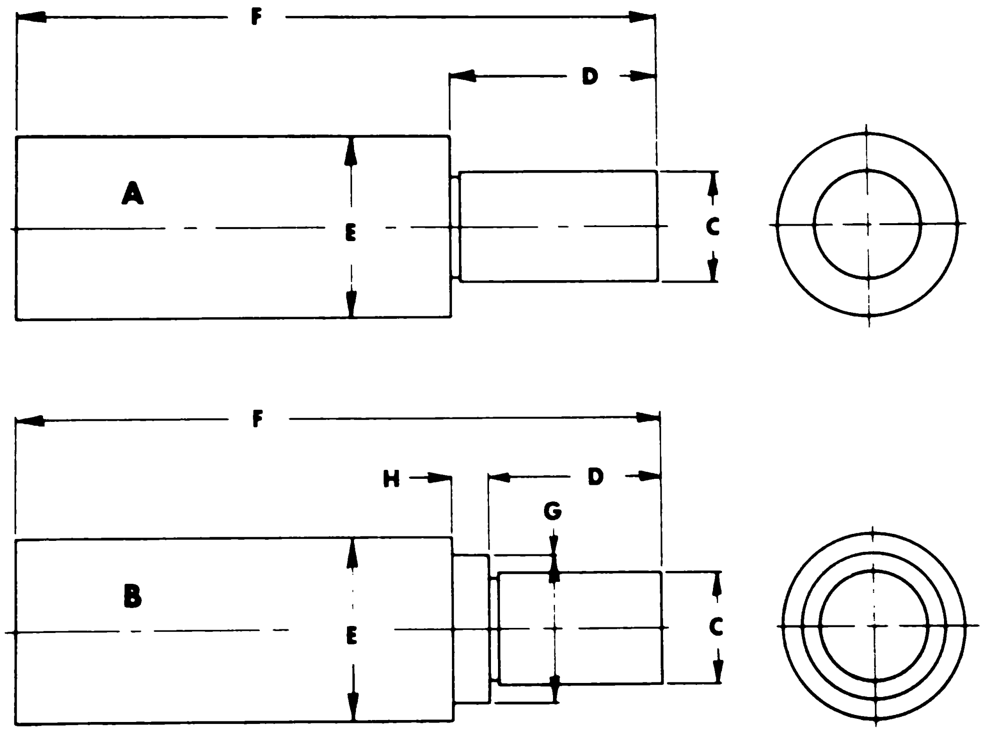
a. Miscellaneous.

Contact File (For dressing regulator contacts).

Ohmmeter (For measuring regulator winding resistance).

Hand Tachometer (For measuring cranking motor no load speed).

3 Point Needle Gap (For testing booster coil).



RA PD 317185

Figure 162—Bearing Arbors

b. Arbors. The arbors listed below are suggested for use when installing bearings. The dimensions given correspond to the key letters in figure 162.

Bearing Arbor—(B, fig. 162).

For installing bronze bearings in group 1 generators.

C—0.4743 inch ±0.0001 inch

D—$\frac{13}{16}$ inch

E—1 inch

F—4 inch

G—$\frac{3}{4}$ inch ±0.002 inch

H—$\frac{3}{16}$ inch

Bearing Arbor—(A, fig. 162).

For installing bronze bearings in group 2 generators and groups 1, 2, and 3 cranking motors.

C—0.627 inch ±0.0001 inch
D—1⅝ inch
E—1 inch
F—4¾ inch

Bearing Arbor—(B, fig. 162).

For installing bronze bearings in groups 1 and 3 distributors 0.094 inch below face of housing.

C—0.500 inch ±0.0001 inch
D—1$\frac{3}{32}$ inch ±0.01 inch
E—1 inch
F—4$\frac{5}{16}$ inch
G—0.622 inch ±0.002 inch
H—0.094 inch ±0.005 inch

Bearing Arbor—(A, fig. 162).

For installing bronze bearings in group 2 cranking motors.

C—0.749 inch ±0.0001 inch
D—1$\frac{11}{16}$ inch
E—1 inch
F—4$\frac{11}{16}$ inch

Bearing Arbor (B, fig. 162).

For installing bronze bearings in group 2 distributors and group 2 cranking motors.

C—0.6250 inch ±0.0001 inch
D—1$\frac{1}{16}$ inch ±0.01 inch
E—1 inch
F—4 inch
G—0.875 inch ±0.002 inch
H—$\frac{5}{16}$ inch

Bearing Arbor (B, fig. 162).

For installing bronze bearings in groups 1, 2, and 3 distributors.

C—0.5000 inch ±0.0001 inch
D—1$\frac{1}{16}$ inch ±0.01 inch
E—1 inch
F—4 inch
G—0.650 inch ±0.002 inch
H—$\frac{5}{32}$ inch

Bearing Arbor (A, fig. 162)

For installing bronze bearings in group 3 cranking motors.

C—1.126 inch ±0.0001 inch
D—1$\frac{11}{16}$ inch
E—1½ inch
F—4½ inch

Bearing Arbor (A, fig. 162).
For installing bronze bearings in group 3 cranking motors.
C—1.252 inch ±0.0001 inch
D—1 1/16 inch
E—1 1/2 inch
F—4 inch

Bearing Arbor (A, fig. 162).
For installing bronze bearings in groups 1 and 3 cranking motors.
C—1.001 inch ±0.0001 inch
D—1 1/16 inch
E—1 1/4 inch
F—4 inch

Bearing Arbor (A, fig. 162).
For installing bronze bearings in group 2 cranking motors.
C—0.5310 inch ±0.0001 inch
D—1.000 inch ±0.005 inch
E—1 inch
F—4 inch

Bearing Arbor (A, fig. 162).
For installing bronze bearings in group 2 cranking motors.
C—0.875 inch ±0.0001 inch
D—1 1/16 inch
E—1 1/8 inch
F—4 inch

Bearing Arbor (A, fig. 162).
For installing bronze bearings in group 3 cranking motors.
C—0.752 inch ±0.0001 inch
D—1 5/16 inch
E—1 inch
F—4 1/2 inch

c. Tools for Voltage Regulator.

Gages, voltage regulator, wire type (41-G-507)
Tool, point adjusting, voltage regulators (41-T-3383-52)
Tool, spring tension adjusting, voltage regulators, (41-T-3383-55)

REFERENCES

STANDARD NOMENCLATURE LISTS.

Cleaning, preserving and lubricating materials, recoil fluids, special oils, and miscellaneous related items	SNL K-1
Soldering, brazing and welding materials, gases and related items	SNL K-2
Electrical apparatus units and parts	SNL M-1
Electrical fittings	SNL H-4
Electrical piece material	SNL H-5
Pipe and hose materials	SNL H-6
Pipe, tubing, and hose	SNL H-7
Interchangeability chart of ordnance maintenance tools for combat vehicles	SNL G-27 Vol. 2
Ordnance maintenance sets	SNL N-21
Tools, maintenance, for repair of automotive vehicles	SNL G-27 Vol. 1
Tool sets for ordnance service command, automotive shops	SNL N-30
Tool sets—motor transport	SNL N-19
Current Standard Nomenclature Lists are listed above. An up-to-date list of SNL's and other Ordnance Publications is maintained in the Index to Ordnance Publications	OFSB 1-1

EXPLANATORY PUBLICATIONS.

General.

List of publications for training	FM 21-6
Military motor vehicles	AR 850-15
Standard military motor vehicles	TM 9-2800

Related Technical Manuals.

Automotive electricity	TM 10-580
Basic maintenance manual	TM 38-250
Electrical fundamentals	TM 1-455
Electrical equipment (Auto-lite)	TM 9-1825A

Decontamination.

Chemical decontamination materials and equipment	TM 3-220
Decontamination of armored force vehicles	FM 17-59
Defense against chemical attack	FM 21-40

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